



Raspberry Pi: How to set up time-lapse photography

CUSTOM PC

THE BEST-SELLING MAG FOR PC HARDWARE, OVERCLOCKING, GAMING & MODDING / ISSUE 157

FULL STEP-BY-STEP GUIDE

PC BUILDING MASTERCLASS

**HOW TO
CONSTRUCT A
PC LIKE A PRO**

**REVIEWED:
GEFORCE
GTX 1060**

PLUS

**MICRO-ATX CASE
GROUP TEST
ULTRA-WIDE
MONITORS**



9 771740 744059 10
OCTOBER 2016 / £5.99

RAW POWER. UNCHAINED.



FRAMELESS MECHANICAL GAMING KEYBOARD

Some gamers want all the bells and whistles, whereas gaming purists want raw, undiluted performance. With the Suora, the gaming purists have found their keyboard. The Suora's frameless design channels its philosophy as a pure and efficient mechanical keyboard for no-frills gamers. There's no palm rest, no thick border, no thumb

keys, and no unnecessary media keys – just high-quality, solid mechanical keys mounted on a durable plate. It features a robust, compact build with aluminum alloy housing, providing a consistent, distraction-free platform. With key illumination in fan-favorite ROCCAT® blue adjustable in 11 brightness levels, you won't miss a key.



FRAMELESS MECHANICAL
GAMING KEYBOARD

MORE INFORMATION
WWW.ROCCAT.ORG/SUORA

Welcome

.....
Custom PC Issue 157

**Editorial
EDITOR**
Ben Hardwidge
editor@custompcmag.org.uk

MODDING EDITOR
Antony Leather

GAMES EDITOR
Rick Lane

ART EDITOR
Bill Bagnall
www.billbagnalldesign.com

PRODUCTION EDITOR
Julie Birrell

CONTRIBUTORS
Edward Chester, Gareth Halfacree,
James Gorbould, Joe Martin, Mike Jennings,
Paul Goodhead, Richard Swinburne,
Simon Treadaway, Tracy King

PHOTOGRAPHY
Antony Leather, Ben Hardwidge,
Gareth Halfacree, Mike Jennings

**Publishing & Marketing
GROUP PUBLISHER**
Paul Rayner
paul_rayner@dennis.co.uk

LICENSING MANAGER
Carlotta Serantoni
Carlotta_Serantoni@dennis.co.uk
+44 (0)20 7907 6550

**LICENSING &
SYNDICATION ASSISTANT**
Nicole Adams
Nicole_Adams@dennis.co.uk
+44 (0)20 7907 6134

SYNDICATION SENIOR MANAGER
Anjum Dosaj
+44 (0)20 7907 6132

Commercial & Advertising
Paul Rayner
paul_rayner@dennis.co.uk

The paper used in
this magazine is
produced from
sustainable fibre, manufactured by mills
with a valid chain of custody.



Dennis Publishing Limited
Tel: 020 7907 6000 fax 020 7907 6193

DIRECTOR OF ADVERTISING
Julian Lloyd Evans

**MANAGING DIRECTOR
DENNIS TECHNOLOGY**
John Garewal

CEO
Ian Westwood

NEWSTRADE DIRECTOR
David Barker

FINANCE DIRECTOR
Brett Reynolds

GROUP FINANCE DIRECTOR
Ian Leggett

CHIEF EXECUTIVE
James Tye

COMPANY FOUNDER
Felix Dennis

Subscriptions

You can manage your existing subscription
through www.subsinfo.co.uk – this should be
your first port of call if you have any queries
about your subscription. Email: custompc@servicehelpline.co.uk

Annual subs: UK £44.99
UK subs: 0844 844 0032

Overseas subs:
Europe £65, ROW £85
Overseas subs: +44 (0)1795 592 906

LICENSING, REPRINTS, EPRINTS
Wright's Media
0800-051-8327 (Toll Free)

Printed by BGP

Distributed by Seymour Distribution
Tel: 020 7429 4001

OVERSEAS NEWSSTAND
Geraldine Grobler, Seymour International
Ltd., +44 (0)20 7429 4066

Custom PC is produced by Mr Freelance Limited, and
published monthly by Dennis Publishing Ltd, 30 Cleveland
Street, London W1T 4JD, a company registered in England
number 1138891. Entire contents © Dennis Publishing Ltd
licensed by Felden. © Copyright Dennis Publishing Limited.
Custom PC is a trademark of Felix Dennis.

.....
DON'T TRY THIS AT HOME The information in this magazine is given in good faith. Dennis Publishing Limited cannot accept any responsibility for loss, disruption or damage to your data or your computer that may occur as a result of following or attempting to follow advice given in the magazine. If things do go wrong, take a break.

Contents

Welcome to Issue 157

86 PC building masterclass

If you've ever looked at a professional system build and thought 'how do I do that?' then this issue is for you. In our PC building masterclass, we take you through the whole process of building a PC, from start to finish. We tell you which slots and sockets to use for which components, where to put your fans and, perhaps more importantly, where to put all those cables and make a PC that looks like it was built by a pro.

Whether you're considering building your first PC, or if you've built a couple of machines already but want some tips and tricks, there will be something for you in our complete masterclass.

COVER STORY
P86



Highlights

- 10** A proper next-gen PC
Unimpressed by tradeshow concept projects, Richard Swinburne shows how the PC can be really improved.
- 12** VR sickness
VR will only become mainstream if it doesn't make gamers feel sick, argues Tracy King.
- 20** Nvidia GeForce GTX 1060
Nvidia's cut-price Pascal chip takes aim at AMD's Radeon RX480.
- 28** Water cooling on the cheap
Alphacool's sub-£100 Eisbaer 240 promises an easy introduction to water cooling, with a complete, expandable pre-built kit that challenges all-in-one liquid coolers.
- 40** Ultra-wide monitors
Fancy having a mini IMAX in your



face? We put six massive, ultra-wide monitors through their paces.

- 50** Micro-ATX cases
Smaller than an ATX case, but less restrictive than a mini-TX chassis, micro-ATX is a happy medium between both worlds. We test six micro-ATX cases to find the best ones.



Gareth Halfacree shows you how to make a time-lapse photography video using any model of Raspberry Pi board.

- 96** Raspberry Pi time-lapse photography

- 104** Expand an all-in-one liquid cooler
Want to add a bigger radiator or a separate reservoir to your all-in-one liquid cooler, as if you had a proper custom water-cooling system? Antony Leather shows you how it's done.



Regulars

- 8 From the editor
- 10 Richard Swinburne
- 12 Tracy King
- 14 Incoming
- 16 Letters
- 34 Custom kit
- 38 How we test
- 64 Elite
- 75 Inverse look
- 82 The engine room
- 96 Hobby tech
- 101 RealBench leaderboard
- 102 Customised PC
- 104 How to guides
- 109 Your folding milestones
- 110 Readers' drives
- 114 James Gorbod

Cover guide



31
PRODUCTS
REVIEWED

Reviewed this month

Reviews

FAN

- 19 Corsair ML120 Pro LED

GRAPHICS CARDS

- 20 Nvidia GeForce GTX 1060 6GB
- 22 Asus Radeon RX480 ROG Strix OC Gaming 8GB

ATX CASE

- 24 SilverStone Primera PM01

MONITOR

- 26 ViewSonic XG2700-4K

CPU COOLER

- 28 Alphacool Eisbaer 240

LOUNGE GAMING DEVICE

- 32 Roccat Sovia

Custom kit

- 34 Misfit Ray
- 34 Tyre Pilot STP1400
- 34 Revolve PCB coasters
- 35 Skullcandy Shrapnel
- 35 Gradient Puzzle
- 35 BT Smart Hub

Ultra-wide monitor Labs

- 42 Acer Predator X34
- 43 AOC C3583FQ
- 44 AOC U3477PQU
- 45 Asus ROG Swift PG348Q
- 46 Philips Brilliance BDM3490UC
- 47 Samsung S34E790C

Micro-ATX case Labs

- 51 Cooltek UMX3
- 52 Corsair Obsidian 350D
- 53 Fractal Design Arc Mini R2
- 54 Phanteks Enthoo Evolv MATX
- 55 Raijintek Styx
- 56 SilverStone Kublai KL06

Games

- 76 Mirror's Edge: Catalyst
- 78 The Witcher 3: Blood & Wine
- 78 Duskers
- 80 Sherlock Holmes: The Devil's Daughter

Hobby tech

- 98 WeMos D1R2
- 100 The Essential Guide to Electronics in Shenzhen



CyberPowerPC recommends Windows.
One experience for everything in your life.

Infinity Xtreme Pro



Windows 10 Home

Intel® Core™ i7-6900K Processor

ASUS® X99-A Mainboard
16GB DDR4 3000mhz Corsair Vengeance LPX Memory
480GB Kingston UV300 SSD
2TB SATA III 6.0Gb/s 64MB HDD
8GB MSI Nvidia® GeForce® GTX 1080 Video Card
16X LG® Blu Ray BH16NS40 Writer Black
CoolerMaster Staker 935 Gaming Case
CoolerMaster B600 Power Supply
Cyberpower Advance Water Cooling system
Extreme Overclocking
LCD monitor is not included but optional



16x Optical Drive



HD 7.1



CoolerMaster®



CoolerMaster®

FROM
£2629



Liquid Cooling
Included

Infinity Xtreme



Windows 10 Home

Intel® Core™ i7-6800 Processor

MSI® X99A RAIDER Mainboard
16GB DDR4 3000mhz Corsair Vengeance LPX Memory
240GB Kingston UV300 SSD
2TB 7200rpm SATA III 6.0Gb/s 64MB HDD
8GB MSI Nvidia® GeForce® GTX 1070 Video Card
NZXT H440 Gaming Case
Corsair CX600 Power Supply
Corsair H55 Cooling System
LCD monitor is not included but optional



FROM
£1575



HD 7.1



CoolerMaster®



CoolerMaster®

Infinity X55



Windows 10 Home

Intel® Core™ i5-6600K Processor

Gigabyte Z170-HD3 Mainboard
8GB DDR4 2400mhz Corsair Vengeance LPX Memory
2TB 7200rpm SATA III 6.0Gb/s 64MB HDD
2GB MSI Nvidia® GeForce® GTX 960 Video Card
NZXT Source 340 Mid Tower Black
Corsair VS 450W Power Supply
Corsair H55 Cooling System
LCD monitor is not included but optional



FROM
£885



HD 7.1



CoolerMaster®



CoolerMaster®

Order your **ultimate gaming system** today! www.cyberpowersystem.co.uk

All Desktop systems come with 3 year Limited Warranty + lifetime toll free techsupport

CyberPowerPC, CyberPowerPC Logo and, Unleash The Power are trademarks of CyberPower Inc. Copyright © 2013 CyberPower. All rights reserved. All prices are subject to change without notice or obligation. Celeron, Celeron Inside, Centrino Inside, Centrino Logo, Core Inside, Intel, Intel Logo, Intel Core, Intel Inside, Intel Inside Logo, Intel Vii, Intel vPro, Itanium, Itanium Inside, Pentium, Pentium Inside, Vii Inside, vPro Inside, Xeon, and Xeon Inside are trademarks of Intel Corporation in the U.S. and other countries. All prices are subject to change without notice or obligation. CyberPower is not responsible for any typographical or photographic errors. NVIDIA®, nForce®, GeForce®, SLI™ are trademarks or registered trademarks of NVIDIA Corporation or its subsidiaries in the United States and other countries. CyberPower PCs use genuine Microsoft® Windows®, www.microsoft.com/plracy/howtotell

Intel Inside®. Amazing Experience Outside.



LIQUID COOLING INCLUDED

CPUs with standard fansinks can reach core temperatures as high as 130°C, however, liquid cooling can lower that to 59°C giving you better performance and longer lifespan on your CPU.

£54.99
VALUE

Infinity X33



Windows 10 Home

Intel® Core™ i3-6100 Processor

MSI B150M PRO-VDH Mainboard
8GB DDR4 2133mhz Kingston Value Memory
1TB 7200rpm SATA III 6.0Gb/s 64MB HDD
2GB Nvidia® GeForce® GTX 950 Video Card
CoolerMaster Elite 310 Mid-Tower Case
Thermaltake Litepower 350W Power Supply
Corsair H55 Cooling System
LCD monitor is not included but optional



FROM
£655



24X DVD ±RW



HD 7.1



CoolerMaster®



CoolerMaster®

Infinity X77



Windows 10 Home

Intel® Core™ i7-6700K Processor

ASUS® Z170-P Mainboard
8GB DDR4 2400mhz Corsair Vengeance LPX Memory
120GB Kingston UV300 SSD
1TB 7200rpm SATA III 6.0Gb/s 64MB HDD
4GB MSI Nvidia® GeForce® GTX 970 Video Card
Corsair 450D Gaming Case
CoolerMaster B600 Power Supply
Corsair H55 Cooling System
LCD monitor is not included but optional



FROM
£1175



24X DVD ±RW



HD 7.1



CoolerMaster®



CoolerMaster®

Fangbook 4 SX6-100



Windows 10 Home

Intel® Core™ i7-6700HQ Processor

15.6" Full HD 1920 x 1080 Display
Intel HM170 Express Chipset
Nvidia® GeForce® GTX 960M 2GB Video Card
4GB DDR4 2133MHz HyperX Impact Black Memory
500GB 5400RPM SATA HDD
Intel® Dual Band Wireless-AC 3165 WiFi
Bluetooth 4.0 Combo



FROM
£789



8X DVD ±RW



180 Mins



Bluetooth 4.0



2x USB 3.0
1x 3.1 Type C

1x HDMI Port

Built-in 720P HD Webcam

2.4 kg

AC WIFI

Fangbook 4 Xtreme G-Sync 200



Windows 10 Home

Intel® Core™ i7-6700 Processor

15.6" UHD 3840 x 2160 Display
Intel Z170 Express Chipset
Nvidia® GeForce® GTX 980M 8GB Video Card w/G-Sync
16GB DDR4 2133MHz SODIMM memory
2TB 5400RPM SATA HDD
240GB SM2280 S3 M.2 SSD
Intel® Dual Band Wireless-AC 8260 WiFi
Bluetooth 4.0 Combo



FROM
£1609



250 Mins



Bluetooth 4.0



3x USB 3.0
1x 3.1 Type C

1x HDMI Port

Built-in 720P HD Webcam

2.4 kg

AC WIFI



CYBERPOWERPC
UNLEASH THE POWER

ORDER TODAY! **0844 371 2727**
www.cyberpowersystem.co.uk

Cortana available in select markets at launch, experience may vary by device.
*External monitor must support HDMI input, if continuum compatible accessory is not included, add. *Accessories sold separately.† App availability and experience varies by device and market. Office 365 subscription required for some features. ‡ Limited to select premium phones at launch. Feature and app availability and experience may vary by market and device. Windows Hello required specialized hardware, including fingerprint reader, illuminated IR sensor or other biometric sensors.

Work easy. Play hard. Windows



BEN HARDWIDGE / FROM THE EDITOR

FRAME AND FORTUNE

Ben Hardwidge asks what frame rates you need to make a game smoothly playable

It must be great being paid to play computer games for a living, though, right? That's what some people have asked me about the amount of time I've spent benchmarking graphics cards with all the recent GPU launches, well into the night, over the past few months. So I'll get this out of the way first. When you're playing the same 60 seconds of Doom 50 times a month, it stops being a game and becomes an exercise in data analysis that clearly has 'work' written at the top of the spreadsheet. It's definitely a lot more fun than the job I had working in an egg box factory when I was a teenager, but it isn't larking about for money.

That said, the data that real-time gaming benchmarks give me is often very interesting, and while that doesn't sound as good as 'I play games for a living', to me, it's far more appealing. Finding those bits of data, as well as getting our hands on all the latest kit, is what makes reviewing hardware on Custom PC so exciting.

All of which brings me on to one of the more interesting facts I've noticed over the past months. Three of our current benchmarks (Doom, Fallout 4 and The Witcher 3) involve us playing a certain section of the game in real time, while FRAPS records the frame rate.

After running these benchmarks hundreds of times, I've consistently found that I get a little further into the game, before the FRAPS timer runs out, when the average frame rate goes beyond around 50fps.

It isn't very far – just a few virtual yards past the usual benchmark path – but the extra frame rate seems to speed up my gaming abilities. Perhaps it undetectably enables slightly quicker reactions, or maybe I don't have to correct my direction after turning a corner so much. I'd love to see some proper data about frame rate perception from multiple gamers with blind

It's not very far, but the extra frame rate seems to speed up my gaming abilities

testing, and we don't have that, but my experience happens often enough for me to suspect that the higher frame rate is indeed making me quicker.

I find this particularly interesting, because the attitude of Custom PC has always been to focus on the minimum frame rate, rather than the average (although we still report the average, of course), and I still think we're right to do so. After all, it's the minimum that you'll really notice if your game slows down to the point of being unplayable. Our general policy is that a 25fps minimum is borderline playable, but you should aim for 30fps if possible.

I think that's still right. A game isn't perfectly smooth with a 30fps minimum, or even a 25fps minimum, but it doesn't judder to the point that it's unplayable. However, I'm now wondering if we need to place a higher emphasis on smooth average frame rates on top of these minimums. Buying a graphics card shouldn't just be about making games playable – it should also be about getting a smooth gaming experience, particularly if you're spending a lot of money. Doom is arguably playable at 4K on an overclocked GeForce GTX 1060 (see p20), but the comparatively low average frame rate means the game is still pretty clunky at 4K with this card.

Our current graphics card scoring system already accommodates higher frame rates, awarding minimums of 45fps and 60fps with more points, but I'm starting to think we should have a closer look at the averages too.

I'd be really interested in your feedback here though. What frame rates do you consider to be acceptable when playing games? Are you more interested in the minimum, average or both? Do you find games easier at a higher frame rate? Let me know at letters@custompcmag.org.uk **GPD**

Ben Hardwidge is the editor of Custom PC. He likes PCs, heavy metal, real ale and Warhammer 40,000. editor@custompcmag.org.uk [@custompcmag](https://twitter.com/custompcmag)

GLADIATOR COMPUTERS

4 Years Warranty | Flexible Customisation | Finance Available

AWARD WINNING GAMING PCS



SNIPER GAMING PC

: INTEL Pentium G4400 3.30GHz Dual Core Processor
: NVIDIA GTX 950 XTREME 2GB Graphics Card
: 4GB DDR4 2133MHz Memory
: 1TB SATA III Hard Drive

FROM **£409.99**



APOCALYPSE GAMING PC

: INTEL i5-6400 2.70GHz Quad Core Processor
: NVIDIA GTX 970 4GB Graphics Card
: 8GB DDR4 3000MHz Memory
: 1TB SATA III Hard Drive

FROM **£779.99**



BATTALION 800 GAMING PC

: INTEL i5-6500 3.20GHz Quad Core Processor
: NVIDIA GTX 970 4GB Graphics Card
: 16GB DDR4 2133MHz Memory
: 120GB SSD + 1TB SATA III Drive

FROM **£889.99**



ALPHA 1080 GAMING PC

: INTEL i5-6600K 3.50GHz Quad Core Processor
: NVIDIA GeForce GTX 1080 8GB Graphics Card
: 16GB DDR4 3000MHz Memory
: 128GB M.2 NVMe SSD

FROM **£1299.95**



£15.00 OFF Your custom build gaming PC when you use this discount code **:D0313**

For great prices & service on Accessories / Computer Components visit our sister site **www.aria.co.uk**



RICHARD SWINBURNE / VIEW FROM TAIWAN

A PROPER NEXT-GEN PC

Uninspired by often implausible 'next-gen' PC projects at trade shows, Richard Swinburne offers his advice for really improving the PC

Every now and then, big players in the PC business show off their ideas for the 'next-generation' PC. They're usually like the concept cars at the Geneva motor show: a bit radical, a bit implausible – it's more about marketing companies as forward thinking than making a realistic product. Occasionally, of course, one of these concepts makes it through to production, such as Intel's dual Xeon 'Skulltrail' platform.

More recently, we've seen Razer's Christine project; to me, this is very pretty but inherently flawed. Having components wrapped in tiny metal boxes hanging off a central column with simple and easy plugs, plus all-liquid cooling, would certainly make PC construction simpler. However, such a system is implausible when you consider the limitations of signal integrity or latency over such distances.

More recently, Asus' ROG Avalon project presented a box-like package that further modularised the motherboard – allowing even a customisable rear I/O system – and removed a lot of the 'messy' stuff from view.

At its core, it still used common PC connectors, which is understandable, as its two main achievements were to remove most of the cabling and add the novel rear I/O blocks. However, it ended up with a big, boxy design that made it hard to see any of the hardware that we love.

So, given that our industry so consistently gets the idea of the 'next-gen PC' wrong, I'd like to propose an alternative. Instead of making these big, implausible jumps, let's make iterative steps forwards to remove the legacy chains holding back a cleaner, more efficient design.

For starters, let's flip PCI-E cards. They should face upwards, not hang downwards – especially graphics cards. ISA cards used

to face this direction, but the switch to PCI flipped them around and they've been like that ever since. Let's go back.

Secondly, instead of having a ludicrous 24-pin ATX power plug, plus another 8-pin EPS plug and sometimes even more power plugs if you load the motherboard with graphics cards, we should have small, single-input cables for motherboards. You could have a single ~24/48V cable between the PSU and motherboard, and let the motherboard do the conversions to lower voltages as required. It would be neater and easier to use than the current setup, and more efficient.

We could do a similar job with GPU power, using a single, high-voltage input that can be converted into a high-amp, lower-voltage input. Right now, graphics card makers want to use as few connectors as possible, and sometimes we end up having to use multiple connectors or adaptors. All of that hassle would go away.

Also, our motherboards currently offer a ridiculous choice of storage interfaces, including SATA, mSATA, M.2 (SATA), M.2 (PCI-E), SATA Express and U.2. Let's be brave, and declare unsuccessful formats such as SATA Express and mSATA dead. After that, the SATA-IO and PCI-SIG need to knock their heads together to provide some clear guidelines. While we're at it, the atrociously flimsy SATA power connector should be replaced with a sturdier and neater connector too.

We need a better way to plug a case's front panel connectors into the motherboard too – it's so fiddly right now! Why isn't there a single connector and cable that combines USB 2 and 3, HD audio and the front switches into one unit? Every case has virtually the same front panel connectors.

Finally, let's stop making products that use Molex plugs. Just, please, stop it. **GPS**

Stop making products that use Molex plugs. Just, please, stop it

Richard has worked in tech for over a decade, as a UK journalist, on Asus' ROG team and now as an industry analyst based in Taiwan @Bindibadgi



LAPDOG

LIVING ROOM GAMING
WITH ZERO COMPROMISE

Bring the ultimate 4K gaming experience to the living room - with the portable gaming control center that brings precision desktop gaming performance to your couch.



LEGENDARY CORSAIR PRECISION

FROM THE COMFORT OF YOUR COUCH

All your gaming gear connected right where you are. Everything you need in a perfectly balanced, ergonomic gaming setup. Precise keyboard control. Generous mouse pad area. No compromises.

**Sold without Keyboard and Mouse*



LEARN MORE AT
corsair.com
/LAPDOG

   /corsair.com



TRACY KING / SCEPTICAL ANALYSIS

VR SICKNESS

VR could become mainstream in 2017, but only if gamers don't feel sick when they're using it, argues Tracy King

Virtual reality has had many false starts. Since the 1980s and the early days of VPL's 'EyePhone' device (head-tracking 'glasses' that looked pretty much like an Oculus Rift and came with a comical black 'Data Glove'), developers have been desperate for VR to take off, but it has stubbornly refused, despite the exciting potential. In the past few decades, there have been tonnes of VR headsets available to the public, from the Nintendo Virtual Boy to the VFX1 for PC. Playing Quake via VR should have propelled it into mainstream gaming, but it didn't.

The Samsung Gear VR has a version of Pocket Minecraft, with a full Oculus version currently in development, and since launch has sold 300,000 units in Europe alone. In total, there are around a million contemporary VR headsets in consumer homes. These signs point to 2017 being the year that VR finally goes mainstream. Except it might not, again. One of the biggest barriers to success is a problem from which all VR headsets have suffered (particularly the aforementioned ill-fated Virtual Boy): motion sickness. The simple fact is that up to half of all VR users will feel sick, dizzy or headache when using VR, and that's a major impediment to its success.

There are two questions facing games developers – why it happens, and how to prevent it. The why is the trickiest bit, because right now no one entirely knows.

With physical motion sickness, perhaps when you're on a boat or in a car, the fluid in your inner ear canals sloshes about, and hairs, which act as sensors, send information to your brain. Your brain matches that information to your vision, and notices that your body is apparently moving and not moving at the same time. You can help this sickness by staring

at the horizon, but that isn't really an option in a VR game. There's no reason your inner ear should be freaking out, as you're not being jogged along by a car or boat, but for some reason, it freaks out anyway, and VR developers have to find a workaround.

There are currently a lot of mooted solutions. Oculus Rift has an improved refresh rate to minimise visual lag, but it doesn't solve the problem for everyone. Other solutions include adding a virtual nose to try and orientate the player, and using motion capture to increase the realism of character movement – according to one theory, VR motion sickness may be caused by the 'uncanny valley' effect, although so far no evidence has emerged to prove this theory.

I spoke to Matt Ratcliffe, a VR expert at Masters of Pie, and he suggested that the solution lies in the types of games being ported to VR. He says that 'any game which involves flying or running around is a candidate for motion sickness, whereas puzzle or adventure games don't seem to trigger the problem so much. Developers need to think about VR as a unique platform, and develop new titles or even genres that don't affect the inner ear'.

If VR is to take off as a mainstream peripheral, developers need to think beyond the strategy of 'stick an existing game on it'. Beyond experimenting with games that incorporate sound cues to recalibrate the inner ear or have stabilised peripheral vision, there needs to be a major shift in thinking when it comes to what's playable for everyone, and whether even the biggest games such as Minecraft are ultimately suitable. VR won't be adopted without playable games, and playable in this context – uniquely – means 'doesn't make me sick'. **EPG**

Staring at the horizon isn't really an option in a VR game

Gamer and science enthusiast Tracy King dissects the evidence and statistics behind popular media stories surrounding tech and gaming @tkingdot

A million computers are waiting to be built.



DARK BASE 900

There may be countless ways to build a PC. But there's one series of PC cases that makes them all possible: Dark Base 900. It offers maximum flexibility to suit your individual space requirements. And of course, it's one of the quietest cases in the world, featuring:

- Repositionable motherboard tray and HDD tray with the option of inverse layout
- Three virtually inaudible be quiet! SilentWings® 3 PWM fans
- Full-circuit airflow system with noise-dampened vents
- Four areas for water cooling radiators up to 420mm
- Dark Base Pro 900 with LED illumination, window with tempered glass and wireless Qi charger

For more information visit bequiet.com



GERMANY'S NO. 1[★]
PSU MANUFACTURER

*GfK data 2016

Available at: scan.co.uk · overclockers.co.uk · ebuyer.com · novatech.co.uk
amazon.co.uk

be quiet!®

Incoming

We take a look at the latest newly announced products



Nvidia unleashes Pascal Titan

It was only a matter of time before Nvidia showed us the full potential of its new Pascal architecture, and the ultimate Pascal part has now been unveiled as the new Titan X, which the company claims has an 'irresponsible amount of performance'. The top-end GPU has a massive total of 3,584 stream processors, representing a big jump from the 2,560 stream processors in the GTX 1080.

The GPU will also be partnered by 12GB of GDDR5X memory running at 2500MHz (10000MHz effective) attached to a 384-bit wide memory interface. The clock speeds are slightly lower than those of the GTX 1080, though, with a 1417MHz base clock and a 1531MHz boost clock. There's no word on UK pricing yet, but with GTX 1080 cards costing over £600, it's likely to be very expensive. If Nvidia's previous GPU strategies are any indication, the Titan X may be followed by a significantly cheaper card based on a cut-down version of the same GPU, perhaps called the GTX 1080 Ti. We'll bring you a review of the new Titan X as soon as we can get hold of a sample.



Asus brings Aura to Z170 Pro Gaming

Asus is continuing its strategy of updating its motherboard and graphics cards to support its programmable RGB lighting system, controllable through its Asus software, with the new Z170 Pro Gaming Aura. Other changes to the board include the sensible removal of the SATA Express connectors, as well as the addition of the interesting ability to add 3D-printed parts to the PCB, such as the pictured Asus nameplate over the M.2 slot.

AMD unveils cheaper Polaris chips

AMD has lifted the lid on two new GPUs based on the Polaris architecture. Again, AMD is aiming for the mainstream, high-volume end of the market, rather than the high-end sector. First off is the Radeon RX470, which has a boost clock speed of 1206MHz and 32 compute units, giving you 2,048 stream processors compared with the 2,304 stream processors in the RX480. The chip will be partnered with 4GB of GDDR5 memory running at 1650MHz (6600MHz effective) and a 256-bit memory interface.

Also announced is the much more cut-down RX460 (pictured), which has just 14 compute units (896 stream processors) and a 128-bit memory interface that connects to either 2GB of 4GB of 1750MHz (7000MHz effective) GDDR5 memory. There's no news on UK pricing yet, but AMD says it expects the RX470 to be available on 4 August, with the RX460 following on 8 August. We'll aim to get reviews as soon as we receive samples.



Vulkan comes to Doom

ID Software has brought support for the Vulkan API to Doom. Originally developed by AMD, Vulkan is a cross-platform open API intended to enable game developers to get 'closer to the metal' and circumvent some of the overheads of Windows, squeezing more performance out of a GPU. You can select the new API in the game's Advanced options. Sadly FRAPS currently doesn't work with Vulkan (although an update is rumoured to be in development), so we've been unable to get a fully accurate report of minimum and average frame rates.

However, we've tried it on a Radeon RX480 with the latest driver and it works fine. We also managed to get a very rough idea of the average frame rate by using the game's Performance Metrics feature, and dividing the number of frames it reports by the time taken to complete our benchmark. Running at 2,560 x 1,440 with Ultra settings, the average of 68fps in Vulkan looks like a big jump from the 57fps we saw in OpenGL. We'll look more closely at Vulkan performance when a supporting version of FRAPS (or a similarly accurate tool) is available.



AWARD WINNING PCS • 3 YEAR WARRANTY ON ALL OF OUR SYSTEMS • FEATURING GTX 10 SERIES CARDS

- Intel® Core™ i7-6700K Processor
- Z170 Motherboard
- Up to 16GB 3200MHz DDR4 Memory
- Samsung NVMe/SSD/Seagate HDD
- 80+ Gold Rated PSU
- GeForce GTX 1080
- Custom Watercooling



GET A GAMING PC TO SUIT YOUR BUDGET WITH THE NEW NVIDIA GEFORCE GTX 1060, 1070 & 1080 GRAPHICS CARDS!

**INTEL INSIDE.®
EXTRAORDINARY PERFORMANCE OUTSIDE.**



TITAN NEUTRON

AVAILABLE WITH I5 &
NVIDIA GTX 1060 GPU



TECHLABS CHAMELEON

AVAILABLE WITH I7 &
NVIDIA GTX 1080 GPU



TITAN BAYONET

AVAILABLE WITH I5/I7 &
GTX 1060/1070/1080



TITAN FORCEBOX VR10

AVAILABLE WITH I3/I5 &
GTX 1060/1070/1080

Letters

Please send us your feedback and correspondence to
letters@custompcmag.org.uk

Water-cooling Pascal

A while back, Antony wrote a great piece on the merits of water-cooling AMD's toasty Hawaii chip. In fact, I went on to water-cool my Radeon R9 290X after reading that very article!

How about a similar write-up for the new GTX 1080? Reviews of third-party air cooled boards seem to show the chip is capable of much more, provided it's well cooled. I'm perhaps more interested in the clock speed consistency in a real-world gaming session, rather than the average frame rate recorded over a 60-second benchmark, where the card has the time to cool off in between runs and the merits of water cooling won't be highlighted. Keep up the good work, team!

SÉBASTIEN COMBERBACH

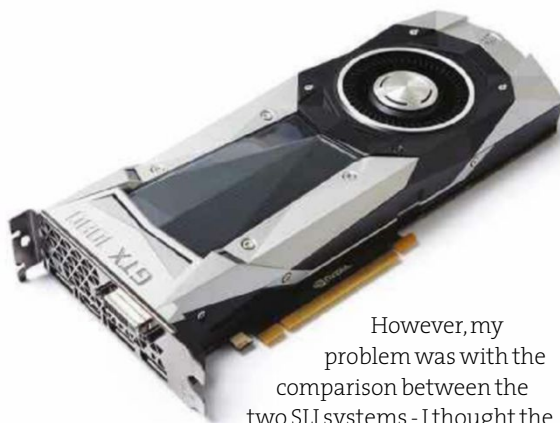
Ben: That sounds like a great idea, Sébastien. The only problem is that it's currently hard to get hold of GTX 1080 samples, particularly if you're planning to dismantle them. I've discussed it with Antony and he agrees that a piece on water-cooling Pascal would be great though – it may end up being a GTX 1070 rather than a 1080, but it should still be interesting. Watch this space.



Bang per buck vs bells and whistles

I've been a subscriber for three or four years now, and I always look forward to **Custom PC** coming through the letterbox! However I've noticed what I think is a prejudice in **CPC's** ratings of pre-built systems and laptops. Most recently, the 'Full 1080' Labs test pitted six machines from various system builders against each other.

Overall, I liked the test and learned a few facts about Broadwell E vs Skylake as a whole.



Could you overclock a GTX 1080 even further using water cooling?

However, my problem was with the comparison between the two SLI systems - I thought the scoring between them was dubious. Both machines had a Core i7-6800K overclocked to 4.2GHz, two GTX 1080s card and an Asus X99 motherboard with similar pricing. The only differences in the core components was the RAM (16GB vs 32GB) which we know makes a negligible, if any difference to most people, and one PC had an M.2 SSD while the other one had a standard SATA model. This is the only area I could find that might account for a noticeable (if slight) difference between the operation of each system.

The time spent planning and installing a water-cooling system costs money too

Anyway, the difference in application benchmarks between the two PCs was overall less than 1 per cent. The total difference in frame rates across the games you used was less than 3 per cent in two

of them, and just 1 per cent in one of them. And what was the price difference between them? For that small performance improvement, you paid £4,100 compared to £2,430!

Why was the value score in between the two PCs judged to be insignificant (just two points out of a possible 25)? Is building a super system that can more or less match the benchmarks of a system that costs almost twice its price really only worth a miserable two points? I've noticed this kind of scoring in laptop tests as well – where a powerful system is underscored despite costing way less than the one with more flashing lights.

I'm much more interested in wringing the most functional performance out of my money than in programmable LEDs. I want bang for buck in my gaming PC; luxuries aside, I want speed, power, efficiency and **VALUE!**

IAN VAUGHAN

Ben: In terms of bang per buck, you're absolutely right – the PC Specialist Vanquish Gamer Extreme III gives you a much better deal than the Scan 3XS X99 Carbon Fluid GL SLI in terms of performance and core components. However, when you're paying several thousand pounds for a system, we're looking for more than bang per buck – we're looking for a system that an average **Custom PC** reader couldn't easily throw together themselves, and that's what was missing from that particular PC Specialist machine.

In our defence, it does also clearly say in that review's conclusion that it 'makes a good alternative to the expensive Scan if gaming performance is your top priority'.

The Value score doesn't just take performance and core components into account though, it also looks at design and that's where the PC Specialist



I want bang for buck in my gaming PC; luxuries aside, I want speed, power, efficiency and VALUE!

machine fell down. The Scan PC didn't just come with programmable LEDs, it had a full custom water-cooling loop with rigid tubing. The build was tidier inside, and well planned in terms of positioning the water-cooling parts and routing the cables. It was also cooler and quieter than the PC Specialist machine. The extra money not only buys you all the water-cooling gear, but also the time spent planning and installing them, and that care is what you're really paying for when you buy a prebuilt system.

I think there's a conflict here between bang per buck and value for the whole package. In a Labs test with a variety of price points, you're not going to get a scoring system that accurately accounts for both definitions, and perhaps that's something we can address by setting a price limit if we do another PC Labs test. The scores aren't everything though – if in doubt, reading the whole review will give you the information you need to make a buying decision.

Thanks for your opinions

I've been buying your magazine for a while, but recently took the plunge and set up a subscription – it was great to receive a toolkit too. The magazine is insightful, informative and very enjoyable. In the wrong hands, there's always a risk that any IT-related magazine could become dry and esoteric. The passion of both the editor and the writers is infectious. It's what makes buying the magazine an enjoyable part of each month. I may even enjoy the magazine more now that I don't have to go and pick it up myself.

One real big strength of your magazine is the opinion pieces. Whether we're talking sci-fi, history

or IT, magazine has to balance news and reviews with opinions. It gives the magazine a flavour, and lets us know the personalities behind the magazine. I think any publication, devoted to any subject, would soon become formal and distant without opinion.

Also, many thanks for continuing to have a letters page. So many magazines have dropped letters pages in recent years. Thank you again and keep up the good work. I'm proud to be a subscriber.

STEPHEN PARRY

Ben: Thank you for your very kind words, Stephen – it's good to know we're getting it right for the most part, and I completely agree about the need for good opinion pieces.

Calculating efficiency

Having an article in Issue 155, p54 with comparative fan noise measurements was indeed fantastic. However, your so-called 'efficiency' measure grated a bit. Efficiency is usually the useful output divided by whatever you put in to get it, so I would have expected airflow to be the numerator not the denominator. Wouldn't you be better calling it a 'figure of merit'?

Even then, I would invert your definition to have airflow divided by noise figure, though, so that the numerical value would be the

WHEN'S THE NEXT MAG COMING OUT?

Issue 158 of Custom PC will be on sale on Thursday, 15 September, with subscribers receiving it a few days beforehand.



Twitter highlights

Follow us on Twitter at @CustomPCmag



frickertom Just built your recommendation for budget gaming PC exact specs but getting slowdown during some games at 1080p – any tips?

Ben: Start by checking your CPU temperature – if it's throttling hard then game performance will drop. You may need to reseat your CPU cooler and reapply any thermal paste. Also, while it's not sanctioned by Intel, there's an ASRock BIOS available for that enables you to overclock the CPU – see our last budget PC build feature (Issue 151, p82) for details on how to do it.



Lincoln_Ess and relax!

Ben: Perfect!



PCEnthusiastUK Hi, Gone beyond milestone of

5,000,000 @foldingathome points now. Quite pleased with this.

Ben: Great stuff, congratulations.



ImCinderz Getting my lad on the PC scene early! He loves the mags.

Ben: Excellent, get him started early!



MintyChu All the dust cleaned out of my old system to help deal

with the hot (I hope) summer.

Ben: An excellent idea. James Gorbald also agrees on p114.



highest on a fan with high airflow and low noise. Food for thought, perhaps? Also, it seems to me that the gremlins got at the 'Airflow at 12V' bar chart (p60) in quite a comprehensive way!

JOHN KNIGHT

Antony: As I mentioned to reader Stuart Harrison in another letter in Issue 156, the fan Labs was the first time we've done this kind of test, so any feedback is very welcome to ensure we're testing accurately and also presenting results you actually find useful. We'll certainly look at using that calculation for efficiency in future tests, and yes, that graph does seem to have done a backflip! **CPC**

Send your feedback and correspondence to letters@custompcmag.org.uk

Reviews

Our in-depth analysis of the latest PC hardware



Reviewed this month

Corsair ML120 Pro LED p18 / Nvidia GeForce GTX 1060 6GB p20/

Asus Radeon RX480 ROG Strix OC Gaming 8GB p22 / SilverStone Primera PM01 p24/

ViewSonic XG2700-4K p26 / Alphacool Eisbaer 240 p28 / Roccat Sova p32 / Custom kit p34

FAN

Corsair ML120 Pro LED / £20 inc VAT

SUPPLIER www.scan.co.uk

Corsair's fans have an enviable reputation that's backed up by excellent 5V and 12V performance in our recent fan Labs test (see Issue 155, p56), where the SP120 Quiet Edition picked up two awards. However, Corsair has finally decided it's time for an update to its 120mm and 140mm fan ranges, introducing the ML-series in both sizes, with a standard LED-less version, along with LED-equipped flavours with white, red or blue LEDs.

The biggest change, apart from an aesthetic tweak, is the bearing. The SP120-series used a hydraulic bearing, which proved to be relatively quiet. The ML-series, though, dispenses with this bearing in favour of a magnetic levitation bearing and a custom rotor design. The idea is that the ML-series fans can offer higher performance at lower noise levels. The bearing is also meant to increase lifespan – in theory, friction is much less of an issue.

The design of the blades is similar, though, and with the same number of fan blades too. However, they feel slightly thinner and have sharper edges than the SP120-series' blades. Unlike the SP120-series fans, all the ML fans are

4-pin PWM-controlled too, and Corsair stipulates that PWM should be used for the best performance. That's because the fans require a constant 12V input, so PWM must be used to adjust the speed below the maximum rated speed.

Such a setup is fine if you plan on hooking up the fans to your motherboard, but some fan controllers lack 4-pin PWM headers, and the ML-series fans can be

quite noisy at very low voltages without PWM control. All the 120mm fans sport a speed range of 400–2,400rpm and a noise rating of 16–37dBA, along with up to 75cfm of claimed airflow and a power draw of just under 0.3A. The ML120-series' 60cm cables are also longer than the paltry 30cm cables that came with the SP120 series

As Corsair recommends the use of PWM, we changed our usual fan testing kit to be powered by a motherboard instead of a fan controller. We're also in the process of tweaking our new fan test rig and, as a result, our numbers aren't comparable with the results in our recent fan Labs test. However, we have retested the High Performance Edition of the SP120 on the same test setup, which has similar specifications to the ML120.

Setting both fans to 1,000rpm in PWM mode, performance was similar. The ML120 was 1dBA quieter at 50dBA, with noticeably less motor noise, while the SP120 sported a slightly higher airflow of 1.2m/sec through our 120mm Monsta radiator, which was 0.1m/sec higher than the ML120's airflow. At 1,500rpm, the fans were indistinguishable noise-wise, although the SP120 was just ahead in terms of airflow, touching on 1.7m/sec compared to



the ML120's 1.6m/sec. At the SP120's maximum speed of 2,350rpm, it had a small lead over the ML120, being 3dB(A) quieter and producing slightly more airflow too, but you wouldn't want to use either fan at these settings anyway, as they're hideously loud.

Conclusion

As long as you have PWM control, Corsair's new ML120-series fans perform excellently, especially at low and medium speeds, where there's noticeably less motor noise than the older SP120 High Performance Edition fans at the same rpm, albeit with a very slight reduction in airflow through our test radiator. The downside is that they cost £5 more than the SP120 equivalent, although they offer snazzy LED lighting and have much longer cables too.

ANTONY LEATHER

/SPECIFICATIONS

Max speed 2,400rpm

Stated noise 16–37dBA

PWM Yes

LEDs Yes

Accessories Cable ties, fan screws

PERFORMANCE

55/60

FEATURES

7/10

SOUND QUALITY

18/20

VALUE

4/10

OVERALL SCORE

84%

VERDICT

Corsair's new fans continue its sound reputation in PC cooling, although they're not much better than the older, cheaper models performance-wise.

GRAPHICS CARD

Nvidia GeForce GTX 1060 6GB / **£230** inc VAT (cheapest stock card) /**£304** inc VAT (Asus Strix stock card) / **£326** inc VAT (Asus Strix OC card)SUPPLIER www.scan.co.uk

The fruits of Nvidia's Pascal architecture are trickling out, and this month brings the company's new GP106 GPU with it, forming the foundation of the new GeForce GTX 1060. Using the same 16nm FinFET transistors as the high-end GTX 1070 and 1080 GPUs, the GTX 1060 features just two graphics processing clusters (GPCs), each of which contain five streaming multiprocessors (SMs). You end up with a grand total of 1,280 stream processors, compared with the 1,920 in the GTX 1070.

Another key change is the memory interface, which is 256 bits wide on the GTX 1070, but only 192 bits wide on the GTX 1060. With the GDDR5 memory running at 2000MHz (8000MHz effective), this means you effectively get 192GB/sec of bandwidth. You also only get 6GB of memory, compared with 8GB on the GTX 1070, and indeed on some of AMD's new Radeon RX480 cards, but that's unlikely to make a difference at the key resolution of 2,560 x 1,440 at which these cards are aimed.

As with previous Pascal chips, Nvidia is aiming higher with the 1060 than with the TX 960. It's designed to not only beat the GTX 970, but match the GTX 980's speed, while costing a fraction of its launch price. At the time of going to press, GTX 1060 cards cost as little as £230 inc VAT, although Asus' Strix cards demand a large premium for their PCB design and DirectCU III coolers.

You can buy the Strix GTX 1060 in two flavours – one version that runs at stock speed, and one with the core overclocked. At stock speed, the GTX 1060 runs at 1506MHz with a 1708MHz boost clock, but the overclocked Strix card

adds a massive 114MHz to that frequency, with a 1620MHz base clock and 1847MHz boost clock. What's more, that stated boost clock is pretty conservative – the GPU was happily boosting to 2050MHz during our tests on the overclocked card. The overclocked version also runs the GDDR5 memory at 2052MHz (8208MHz effective).

We ran all our usual game tests on the overclocked Asus Strix card in OC mode to get a feel for the maximum performance of this card, but we also ran our 2,560 x 1,440 tests with the card at Nvidia's stock speeds to see how the GTX 1060 holds up generally.

Performance

The first important fact to get out of the way is that the GeForce GTX 1060 is superior to the Radeon RX480 in every respect. Even when running at stock speeds, the GTX 1060 was faster in all our games at 2,560 x 1,440, which is the optimal resolution for these cards, and it



consumed less power too, with our system drawing just 218W from the mains with the stock GTX 1060 at load (and just 68W when idle), which is an

incredible result. The stock Radeon RX480 draws 243W at load, which wowed us just last month, but the GTX 1060's efficiency is a remarkable engineering achievement – hats off to Nvidia here. Importantly, the GTX 1060's performance also beats the last-generation GTX 970, putting it in a similar league to the GTX 980.

In most cases, the difference between the stock GTX 1060 and Radeon RX480 is just a few frames per second, but that's sometimes significant. The 35fps minimum in Fallout 4 at 2,560 x 1,440 with Ultra settings is noticeably smoother than the RX480's 29fps, for example. Meanwhile, the overclocked version of the card pushes the gap even further, never dropping below 30fps in Doom at 4K and sitting significantly in front of the Asus Strix equivalent RX480 card (see p22). The GTX 1060 clearly isn't built for 4K gaming, with our results either unplayable or just borderline playable (with the exception of Doom), but it's a truly fantastic card for gaming at 2,560 x 1,440.

As with the Strix GeForce GTX 1070 OC (see Issue 156, p24) and the Strix Radeon RX480 card, the Asus DirectCU III cooler is fantastic too. Even with the card running in OC mode, it never throttled; the GPU boost clock ran consistently at 2050MHz in games and the fans were practically inaudible, even at load. It looks great too. You pay a premium for this cooler, but it just about justifies the outlay if you have the money.

Conclusion

Nvidia's already started playing whack-a-mole with AMD – just a month after the RX480 came out, the GTX 1060 has hammered it back to its burrow. That isn't to say the RX480 is bad – it's still an efficient and powerful mid-range GPU – but at its current price, it just can't compete with the GTX 1060. If you're looking for a mid-range card that will deal with 2,560 x 1,440 gaming at top settings without struggling, then the GTX 1060 is our current GPU of choice.

We sadly didn't have enough time with our sample card to properly overclock it, but the amount of headroom Asus has managed to secure with its Strix card shows there's plenty of potential there. Once again, Asus has also seriously

/SPECIFICATIONS

Graphics processor Nvidia GeForce GTX 1060, 1506MHz base clock, 1708MHz boost clock (stock version); 1620MHz base clock, 1847MHz boost clock (overclocked version – OC mode)

Pipeline 1,280 stream processors, 48 ROPs

Memory 6GB GDDR5, 8GHz effective (stock version); 8208MHz effective (overclocked version)

Bandwidth 192GB/sec (stock version); 197GB/sec (overclocked version)

Compatibility DirectX 12, OpenGL 4.5, Vulkan

Outputs/inputs 2 x HDMI 2b, 2 x DisplayPort 1.4, 1 x DVI-D-DL

Power connections 1 x 8-pin

Size 298mm long, dual-slot

impressed us with its DirectCU III cooler, which has great-looking RGB LEDs, a full backplate and very quiet operation.

If you have the money, the Asus GeForce GTX 1060 ROG Strix Gaming OC is an awesome card that's noticeably faster and more efficient than the equivalent Strix Radeon RX480

card. However, such a premium card arguably makes much less sense in the GTX 1060's price league than with the pricier GTX 1070. If you're strapped for cash there are plenty of cheaper GTX 1060 cards available.

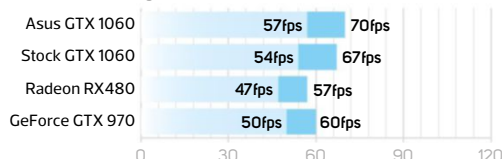
BEN HARDWIDGE

DOOM

1,920 x 1,080, Ultra settings



2,560 x 1,440, Ultra settings

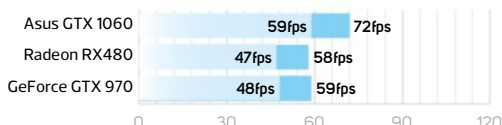


3,840 x 2,160, Ultra settings

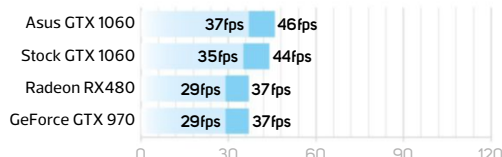


FALLOUT 4

1,920 x 1,080, Ultra detail, TAA



2,560 x 1,440, Ultra detail, TAA

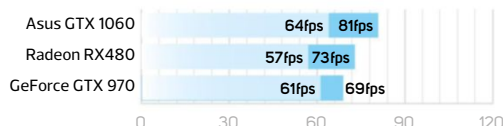


3,840 x 2,160, High detail, TAA

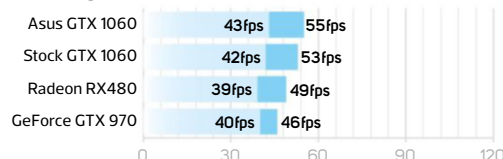


THE WITCHER 3: WILD HUNT

1,920 x 1,080, High detail, Nvidia HairWorks off



2,560 x 1,440, High detail, Nvidia HairWorks off

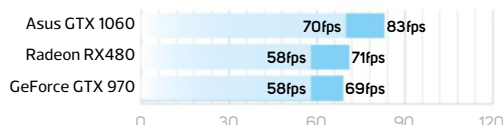


3,840 x 2,160, High detail, Nvidia HairWorks off

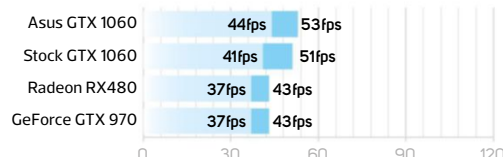


CRYSIS 3

1,920 x 1,080, Very High detail, OX AA



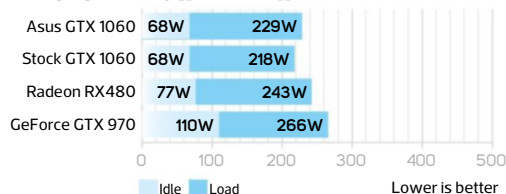
2,560 x 1,440, Very High detail, OX AA



3,840 x 2,160, Very High detail, OX AA



TOTAL SYSTEM POWER DRAW



NVIDIA GEFORCE GTX 1060 6GB



SPEED
42/50

VALUE
34/40

EFFICIENCY
10/10

OVERALL SCORE
86%

ASUS GEFORCE GTX 1060 ROG STRIX GAMING OC



DESIGN & FEATURES
44/45

PERFORMANCE
22/25

VALUE
18/30

OVERALL SCORE
84%

VERDICT

A solid win for the GeForce GTX 1060, which already beats the Radeon RX480. Asus' Strix OC version is also a fine card, although it isn't cheap.

GRAPHICS CARD

Asus Radeon RX480 ROG Strix OC Gaming 8GB / £290 inc VAT

SUPPLIER www.scan.co.uk



After just one month of sitting pretty, AMD's new Radeon RX480 has already been knocked off its mid-range perch by Nvidia's similarly priced but slightly superior GeForce GTX 1060 (see p20) – at least when it comes to stock cards. However, there are still good reasons to consider a good-quality third-party RX480 card, such as Asus' new Strix OC Gaming card.

For starters, we can assure you that you absolutely don't want a Radeon RX480 card with the stock AMD cooler, as the high-pitched whine it makes when it gets going is extremely irritating. Asus' Strix cooler, on the other hand, has already proved itself on the Strix GeForce GTX 1070 OC

(see Issue 156, p24), where it won us over with its combination of effective yet quiet cooling, plus some very fancy LED effects. This cooler is exactly what the RX480 needs – the only problem is that it significantly bumps up the price.

Thanks to the current post-referendum pricing chaos on tech products in the UK, 8GB RX480 cards have already increased in price by around £20 since last month,

but at £290 inc VAT, the Asus Strix card costs a good £50 more than a reference card. That extra money buys you the good cooler, of course, but it also buys you a significant overclock. The RX480's stock speed is 1120MHz with a 1266MHz boost clock, but the overclocked Strix brings that boost clock all the way up to 1330MHz when it's running in OC mode. The memory speed is left at the standard speed of 2000MHz (8GHz effective), however.

As with the GTX 1070 card we reviewed last month, our sample turned up with OC enabled by default, and we tested it at these settings to gauge the maximum

performance. Retail cards will have the Gaming mode enabled by default, which drops the boost clock to 1310MHz, but you can easily enable the OC mode yourself using Asus' GPU Tweak II software.

Aside from clock speeds, there are some other notable differences between AMD's reference RX480 design and the Strix design. One is that the Strix card requires an 8-pin PCI-E power connector, rather than the 6-pin socket on the reference card. According to Asus, the card uses a custom VRM and specially designed PCB to force the GPU to draw all its power from this socket, taking no power from the PCI-E slot itself. It's a response to recent worries about RX480 cards initially drawing more than the

specified maximum of 75W from the PCI-E slot, an issue that AMD has since addressed with a driver fix, but Asus' solution neatly circumvents this problem.

The Strix card is also significantly wider than AMD's reference design, measuring 298mm across, compared with the 243mm stock card. There's a lot of blank space on the PCB, though, so we assume the extra room is mainly needed to accommodate the large cooler.

Again, Asus' DirectCU III cooler is a cracking design, featuring a full backplate that reveals the RGB LEDs (set to your choice of colour and activity using Asus' Aura software) through its ROG logo, as well as a full heatsink layer with heatpipes that make direct contact with the GPU.

It's topped by three fans, and there's even the option to connect two case fans to the card at the end, effectively enabling the card to direct more case airflow through its fins when the GPU gets hot.

Finally, the rear backplate offers a pair of HDMI 2.0b ports, compared with the single port on the reference model, aimed at people using VR, so you can plug one port into a headset and the other into your monitor. There are also two DisplayPort 1.4 connectors.

Performance

The extra 64MHz on the boost clock translates into some healthy gains in our benchmarks, generally adding a couple of frames per second to minimum frame rates. The overclock means Fallout 4 never dropped below 30fps at 2,560 x 1,440 with Ultra settings, and it even brought the Doom minimum frame rate up to a borderline playable 26fps, although the average of 30fps shows this card isn't really built for 4K gaming.

There's even a little room for overclocking beyond these settings, though not much. We managed to get the boost clock running at 1355MHz on our sample, with an extra 200MHz (800MHz effective) added to the memory. Comparatively, we managed to get the boost clock up to 1375MHz on the reference card last month, although the difference is negligible in terms of real-world performance. This extra overclock brought the minimum Crysis 3 frame rate at 2,560 x 1,440 to 42fps – the same result from the overclocked reference card.

Perhaps more importantly, though, the Asus cooler is a massive improvement on the AMD reference cooler. It's barely audible when idle, and while the fan speed increases during games, the noise isn't irritating or overly loud. Power

There's even the option to connect two case fans to the card

/SPECIFICATIONS

Graphics processor AMD Radeon RX480, 1310MHz boost clock (Gaming mode), 1330MHz boost clock (OC mode)

Pipeline 2,304 stream processors, 32 ROPs

Memory 8GB GDDR5, 8GHz effective

Bandwidth 256GB/sec

Compatibility DirectX 12, OpenGL 4.5, Vulkan

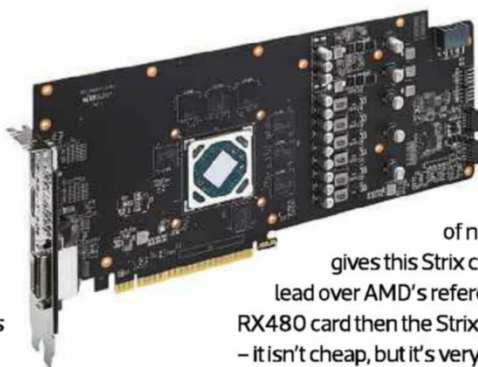
Outputs/inputs 2 x HDMI 2.0b, 2 x DisplayPort 1.4

Power connections 1 x 8-pin

Size 298mm long, dual-slot

consumption is also kept frugal, with the Strix card consuming 261W at load, compared to 243W for the reference card.

Generally, the performance of the Strix RX480 is a little below that of a stock GeForce GTX 1060, showing that Nvidia's new GPU is the superior GPU. However, Asus' Strix GTX 1060 is a fair bit quicker than the Strix RX480 in OC mode, particularly in Crysis 3 and Doom. The performance difference isn't big enough to make the difference between games being playable or not at 2,560 x 1,440, but the GTX 1060 clearly has more headroom, and it draws less power from the mains too.



Conclusion

Asus' DirectCU III cooler not only looks great, but it also massively improves over the AMD reference cooler in terms

of noise. The extra overclock also

gives this Strix card a comfortable performance lead over AMD's reference card. If you want a Radeon RX480 card then the Strix Gaming OC is a superb example – it isn't cheap, but it's very good. The only problem is that the GeForce GTX 1060 is slightly quicker and more efficient. Asus' Strix GTX 1060 OC card costs £36 more than the RX480 equivalent but, if you can afford it, that premium is worth paying for the extra headroom.

BEN HARDWIDGE

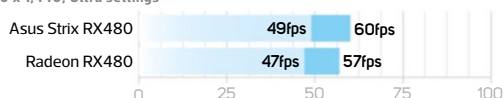
The Strix card is much wider than a reference RX480, although there's a lot of blank space on the PCB

DOOM

1,920 x 1,080, Ultra settings



2,560 x 1,440, Ultra settings

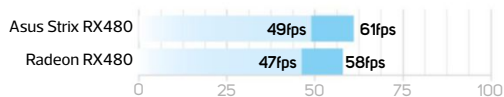


3,840 x 2,160, Ultra settings

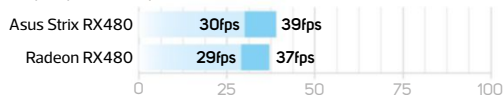


FALLOUT 4

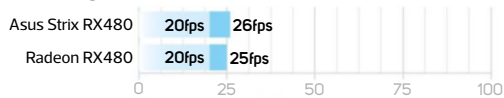
1,920 x 1,080, Ultra detail, TAA



2,560 x 1,440, Ultra detail, TAA



3,840 x 2,160, High detail, TAA

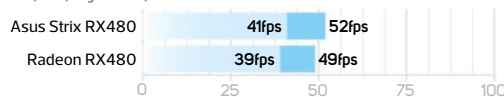


THE WITCHER 3: WILD HUNT

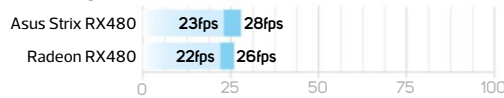
1,920 x 1,080, High detail, Nvidia HairWorks off



2,560 x 1,440, High detail, Nvidia HairWorks off



3,840 x 2,160, High detail, Nvidia HairWorks off

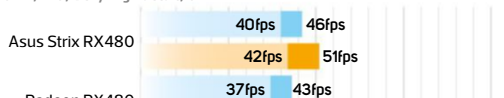


CRYSIS 3

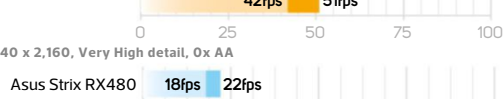
1,920 x 1,080, Very High detail, 0x AA



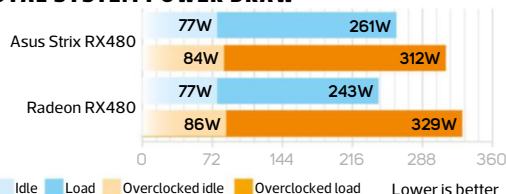
2,560 x 1,440, Very High detail, 0x AA



3,840 x 2,160, Very High detail, 0x AA



TOTAL SYSTEM POWER DRAW



DESIGN & FEATURES

44/45

PERFORMANCE

20/25

VALUE
19/30

OVERALL SCORE

83%

VERDICT

With great looks and quieter operation than the AMD reference card, this is a fine RX480 card, although the equivalent GTX 1060 card is superior.



Aluminum PC Case



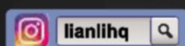
PC-O8 WX

Dim.: (W)341 mm x (H)428 mm x (D)404 mm
Drive Bays: 3.5" HDD x 6, 2.5" HDD x 2
Expansion Slots: 8
M/B Type: ATX
Fans: 120 mm x 6
I/O Ports: USB 3.0 x 4 (20 pin-plug) / HD Audio



PC-Y6 W
2016 SPECIAL EDITION

Distributor



www.lian-li.com Welcome OEM / ODM Project

ATX CASE

SilverStone Primera PM01 / **£90** inc VATSUPPLIER www.scan.co.uk

We'd probably describe the average sub-£100 SilverStone case as being solid, maybe a little plain, but often offering an interesting layout and feature set, as well as good cooling. However, the Primera PM01 marks a change in direction for SilverStone with its striking, sports car-inspired aesthetics and, unusually for SilverStone, it even sports some glossy panels.

However, any snazzy touches to the case's shape are fairly subtle, with the most obvious one being a large glossy plastic shroud on the top that directs exhaust airflow to the rear of the case, hiding any unsightly vents. The Primera PM01 is a high-airflow case though. Its entire front section is a huge mass of mesh, but SilverStone has hidden it away behind some angular edges so that it isn't too in-your-face. Despite its sub-£100 price tag, the PM01 is large, packed full of fans, bristling with LEDs, well-made and very water cooling-friendly too.

The cavernous interior will swallow an ATX motherboard easily, and there are plenty of handy, rubber-lined cable-routing holes around the motherboard tray too. There's a large PSU cover that hides the rest of the cables below the motherboard, and with no storage mounts in the main chamber, it will be easy to build a super-clean system, especially as SilverStone includes several Velcro cable ties too. That's just as well, because the PM01 sports a large side window as standard.

The case comes in three flavours – white with blue LEDs, and either matt or gloss black with red LEDs. All the models offer LED fans in the front, plus various LEDs are peppered around the side panel and roof. If LEDs aren't to your tastes, you can switch them off via a small button on the outside of the case, which can apply different lighting levels too. The

steel construction means the case weighs a hefty 9kg, although this weight isn't excessive when you considering the height and depth measurements of 571mm and 560mm respectively.

A generous count of four 140mm fans is included, three of which act as intakes. As a result, the airflow coming through the front of the chassis is substantial, and is helped by the hush mesh front section. Thankfully, the fans are also very quiet at full speed and only audible within a foot or two of the case. As the fans are so quiet, SilverStone has hooked them all up to a ten-port fan hub, rather than a fan controller, and all the fan mounts are adjustable along short rails too.

The front can house a trio of 120mm fans too, along with a triple 120mm or double 140mm-fan radiator. There's 45mm of clearance between the front mesh and the chassis, plus enough space for a 30mm radiator and single row of fans behind these



front fan mounts too. The roof is also fairly spacious, with just under 73mm of clearance for fans and radiators installed above the motherboard. You can also mount two 120mm fans above the fan mounts in this location, beneath the plastic shroud, allowing you to use a full-height double 120mm-fan radiator. The rear fan mount is well placed for a third single-fan radiator too, and SilverStone has included a mount for reservoirs and pumps next to the motherboard.

If you'll be air-cooling your system, there's an ample 180mm clearance for CPU coolers and 419mm for graphics cards, and the PSU has a roomy 240mm of space beneath the PSU cover. There's a dust filter below the PSU as well, along with a giant filter in the front panel, both of which are removable for easy cleaning.

There's plenty of storage space too – behind the motherboard tray, you'll find two dedicated 2.5in mounts, plus a further three 2.5in bays behind the reservoir mount – you'll be a lucky person indeed if you can fill all these mounts with SSDs. On the downside, the SSD mounts aren't tool-free, unlike the mounts in Corsair's similarly priced options such as the 400C. There are four further drive mounts – three in a cage at the front of the case and one in the base in front of the PSU – that are all able to take a 2.5in or 3.5in drive.

Performance

With so much cooling on tap and a sparse, clutter-free interior, cooling was always going to be a strong point for the PM01. Its CPU delta T of 50°C is spectacular for a sub-£100 case. This result beats any temperature we saw in our recent sub-£100 case labs, and you'd need to spend well over £100 on a case such as Phanteks' Enthoo Luxe to get similar airflow results. The GPU delta T was equally awesome at 50°C, once again trumping any other case recent sub-£100 case we've reviewed, and only topped by much more

/SPECIFICATIONS

Dimensions (mm) 220 x 560 x 571 (W x D x H)

Material Steel, plastic

Available colours Black gloss, black matt, white

Weight 9kg

Front panel Power, 2 x USB 3, 2 x USB 2, stereo, mic

Drive bays 5 x 2.5in, 4 x 2.5in/3.5in

Form factor(s) ATX, Micro-ATX

Cooling 3 x 120mm/2 x 140mm front fan mounts (3 x 140mm fans included), 1 x 120/140mm rear fan mount (140mm fan included), 3 x 120mm/2 x 140mm roof fan mounts (fans not included)

CPU cooler clearance 180mm

Maximum graphics card length 419mm



1
There are plenty of rubber-lined cable routing holes around the motherboard tray

2
The large shroud on the top directs exhaust airflow to the rear, hiding unsightly vents

3
The power supply has a roomy 240mm of space beneath the PSU cover



expensive cases, such as SilverStone's own Fortress FT05. Noise-wise, the fans were easily drowned out by our graphics card, making the PM01 an excellent choice if low noise is top of your list.

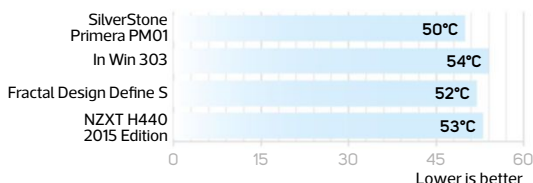
Conclusion

Practically everything about the SilverStone Primera PM01 is good. It will leave you with change from £100, it includes a massive count of four 140mm fans that perform well and are quiet, it has plenty of visual pizzazz, including LEDs and edgy styling, and the build quality is solid. Add the excellent cooling for its price range, plus its superb water-cooling support, and there's very little not to love.

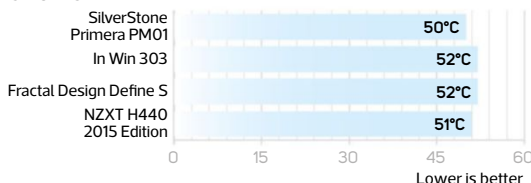
There are a few small niggles; the SSDs mounts aren't tool-free, and some parts of the case, such as the side panels and drive mounts, are a slightly clunky. Many of the panels require screws to be removed too, rather than popping off easily, which will add to build times, especially when water cooling is involved. A fan controller would have been good too, although the fans are already very quiet and powerful. Finally, the design is perhaps a tad garish, but there is a matt option to avoid the gloss, and few high-airflow cases offer such sleek looks anyway. Apart from these small issues, though, the PM01 is a great case for either air-cooled or water-cooled systems, and all for less than £100.

ANTONY LEATHER

CPU LOAD DELTA T



GPU LOAD DELTA T



COOLING
28/30
DESIGN
26/30

FEATURES
16/20
VALUE
18/20

OVERALL SCORE
88%

VERDICT

A big, solid case with great airflow, quiet operation and plenty of room for water-cooling gear for a fantastic price.

MONITOR

ViewSonic XG2700-4K / £480 inc VAT

SUPPLIER www.amazon.co.uk

ViewSonic's XG2700-4K ticks most of the boxes we expect from top-tier gaming panels in 2016, including a huge resolution and support for AMD FreeSync. This active sync tech works similarly to Nvidia G-Sync, matching the monitor's refresh rate with your GPU's frame rate, eliminating tearing. In this case, FreeSync works over HDMI and DisplayPort at a refresh rate between 40Hz and 60Hz. The upper limit is standard for a 4K monitor at the moment, but the 40Hz minimum means you'll need some serious AMD graphics hardware to consistently maintain FreeSync support at the native 4K resolution with high detail settings, as it will stop working once you drop below 40fps. FreeSync worked well when we tried it with our test Fury Nano card, though, with no sign of tearing.

The 3,840 x 2,160 resolution is squeezed into a 27in panel, giving the XG2700 a sharp pixel density of 163ppi, rendering crisp detail when text, images and games are properly optimised. However, you'll have to increase the size of text and icons using Windows' scaling settings to make the display usable, and the odd third-party application will struggle to display properly.

Another great feature of the XG2700-4K is its IPS panel, rather than a TN model, which should lead to great colour accuracy and viewing angles, while the 10-bit colour reproduction enables it to display more than one billion colours. There's a range of input options too, including a DisplayPort 1.2a connector and an HDMI 2 input, plus two standard HDMI 1.4 connectors. There are also four USB 3 ports and a handy headset hook.

The XG2700 doesn't have the good looks of some gaming monitors we've seen lately though – its red accents and thick bezels can't compete with the Asus PG27AQ's appearance, for example. The Asus has a better OSD

navigation system too. The ViewSonic's touch-sensitive buttons aren't as slick or as simple to use as the joystick on the Asus, and the OSD is basic and slow to navigate, although at least it gives you lots of options.

The XG2700's performance is mixed at default settings. Its brightness of 341cd/m² is extreme, while its contrast ratio of 1,217:1 betters the Asus PG27AQ, but its delta E and gamma levels of 2.33 and 2.32 aren't as competitive. Dropping the brightness to a reasonable 150cd/m² saw the ViewSonic really improve, though, where its black level of 0.13cd/m² beats the Asus, and its 6,542K colour temperature barely deviates from the 6,500K ideal. The ViewSonic's revised delta E of 0.56 is also fantastic, as is the 98.8 per cent sRGB coverage.



The preset modes aren't great though. The two FPS modes are either too dim or too bright, and the MOBA option undermines good brightness with poor colours, and the sRGB option ruins contrast. You'll be better off running this monitor at default settings and reducing the brightness.

Finally, three input lag options are available. The standard option's 25.4ms result is a little slow for gaming, but the advanced and extreme modes' respective results of 17.2ms and 9.4ms are much better, with the latter even sneaking ahead of the Asus PG27AQ's 10ms.

Conclusion

The ViewSonic XG2700-4K is a superb gaming monitor for the sub-£500 price tag. It offers superb image quality once you reduce the brightness, even offering broader contrast, superior colours and slightly less input lag than the Asus PG27AQ. It has a wide feature set too, with a good selection of display inputs and support for FreeSync, although you'll need top-notch AMD graphics hardware for the latter. Only the OSD system needs work. The XG2700-4K's best asset, though, is its price. Even if you're not into gaming, this 10-bit IPS panel offers fantastic image quality for the money, but if you have AMD graphics hardware then it's an excellent deal.

MIKE JENNINGS

/SPECIFICATIONS

Screen size 27in

Resolution 3,840 x 2,160

Panel tech IPS

Inputs 1x DisplayPort 1.2a,
1x mini-DisplayPort, 1x
HDMI 2, 2x HDMI 1.4USB 1x USB 3 input, 4x USB
3 outputs

Audio 3.5mm in/out

Power supply External

OSD control Touch-
sensitive buttonsExtras AMD FreeSync
support, headset hookIMAGE
46/50FEATURES
18/20VALUE
28/30OVERALL SCORE
92%

VERDICT

Great image quality, a broad feature set and a fantastic price. If you have fast AMD graphics hardware, it's a great deal.



CPU COOLER

Alphacool Eisbaer 240 / £99 inc VAT

SUPPLIER www.aquatuning.co.uk

There's a small revolution going on in the all-in-one (AIO) liquid cooler market at the moment. With most units being made by Asetek and CoolIT Systems, apart from a few aesthetic differences, most models look and perform very similarly. However, several companies are going beyond the usual sealed unit approach, with one prime example being Alphacool's Eisbaer 240, which is essentially a pre-built custom kit rather than an AIO cooler.

It comes in four flavours that cater for different radiator sizes. The 120mm model sports a 45mm-thick radiator, while the double 120mm, double 140mm and triple 120mm-fan models all use 30mm-thick radiators, which appear to be identical to Alphacool's NexXos ST series of radiators. A single row of Eiswind fans are also included with the kit, which use 4-pin PWM headers and have stated speeds of between 550-1700rpm and a noise rating of up to 29dB(A).

All the parts you need to fit the kit are included in the box, including a PWM Y-splitter cable to hook up the two fans to a single CPU fan header. Meanwhile, the pump and waterblock section is powered just like an AIO cooler, with a 3-pin fan connector. There are screws included to mount the fans to the radiator, and also to mount the radiator to the case – a typical scenario would see it installed in two 120mm fan mounts in your case's roof, given the Eisbaer's relatively short tubes.

The pump, which sports an illuminated Alphacool logo, isn't your average AIO pump either. It's a modified version of Alphacool's tiny DC-LT-2600 Ultra low-noise mini pump, which has a power draw of just 4W, a flow rate

of 70L/h and 0.85m of head pressure. These figures represent a fraction of the performance you'd expect from Laing-based pumps, but while it might struggle to deal with three GPUs, several radiators and VRM waterblocks, it's more than adequate for most high-end systems. However, it has a start-up voltage of around 7V, so make sure the fan header to which you connect it is either set to its maximum speed in your motherboard's EFI, or at least close to it.

The Eisbaer coolers are compatible with all current AMD and Intel sockets, stretching all the way back to LGA1366 and LGA775. For some reason, no instructions are included in the box, but they're available from Alphacool or Aquatuning's websites. For once, we didn't really need them anyway, as the mounting mechanism was blissfully simple to set up. Like many AIO coolers, there's a replaceable two-piece mounting plate that caters for different CPU sockets, and it links up with sprung screws that secure either to a backplate, or in the case of LGA2011 sockets, the mounting mechanism on the motherboard.

However, the mounting plates don't need an army of screws or fiddly clips – they just slot into grooves and cleverly clip together. The mounting pins are similarly intuitive, despite their basic design. You insert them into a spring, which then sits on the mounting plate, creating force when they're screwed into place, while nuts hold the pins in place while you're mounting the pump. Two sachets of Gelid-branded thermal paste are also included, with each one offering enough paste for one application.

Meanwhile, the pump section is fairly large, for the simple reason that it includes a built-in reservoir as well as a pump and waterblock. There's a small side window so you can see the coolant, which is colourless out of the box. However, there's a fill cap that allows you to drain this coolant and use

/SPECIFICATIONS

Compatibility Intel: LGA2011, LGA2011-v3, LGA115x, LGA1366, LGA775; AMD: Socket AM3+, AM3, AM2+, AM2, FM2+, FM2, FM1

Radiator size (with fans) (mm)
279 x 124 x 55 (W x D x H)

Fans 2 x 120mm

Stated noise Up to 29dB(A)

your own coloured coolant. As the fitting threads on both the radiator and pump section are G1/4in sized, they're compatible with most third-party fittings. What's more, as the included fittings are standard compression types that are compatible with 11mm external diameter/8mm internal diameter tubing, it's a simple task to extend the loop to include a graphics card.

However, Alphacool has made that task even easier by including a pre-installed quick-disconnect fitting. These fittings effectively allow you to add tubing, standard fittings, and a male and female quick-disconnect fitting to a GPU waterblock, which you can then insert between the included quick-disconnect fitting without having to drain the system. Only when you secure the fittings together does the valve inside open up and allow coolant to flow through it – they're otherwise sealed. The included quick-disconnect fitting is compatible with Alphacool's own quick-disconnects fittings too, which you can find under part numbers 1010383 and 1010394 on Aquatuning's website.

Performance

The fans on the Eisbaer 240 proved to be almost silent at low-PWM speeds, and noticeably quieter at full speed than those on all of Corsair's AIO liquid coolers we've tested recently. The noise was a match for high-end models such as EK's Predator too. However, the low-noise fans and slim radiator did mean the CPU temperatures were only a few degrees Celsius cooler than the likes of the H110i GT, which still had some muscle when dealing with the heat from our LGA2011 system.

A delta T of 35°C meant it was just ahead of the Corsair cooler, but a couple of degrees warmer than the XSPC RayStorm Pro Ion AX240 kit and EK Predator, which had delta Ts of 30°C and 29°C respectively. In our LGA115x system, the Eisbaer 240 was slightly more ahead of the Corsair cooler, but again a few degrees off the pace of the more expensive options from XSPC and EK. It's clear that there's maybe not enough cooling capacity here to deal with an overclocked CPU and a high-end graphics card, though, so we'd recommend opting for the Eisbaer 360 or adding a second radiator if you're planning such a setup.



Conclusion

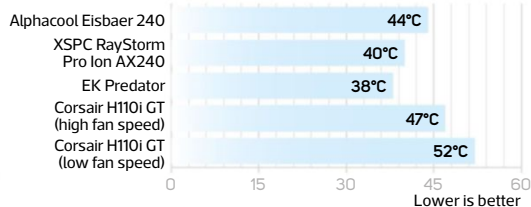
The Alphacool Eisbaer 240 has a lot going for it, and manages to carve out a respectable niche for itself as a result. It's quieter than most all-in-one liquid coolers we've tested, with very little pump noise or fan noise at full speed. It also managed to outperform the mighty Corsair Hydro H110i GT, albeit by only a few degrees, but as the two coolers cost around the same amount of money, it's a solid victory for the Alphacool nonetheless.

Finally, the Eisbaer 240 has excellent expansion options. To be fair, the latest models of the EK Predator now include quick disconnect fittings too, but the Predator is much larger and costs nearly twice as much money. If you want an easy and affordable introduction to the benefits of custom water cooling, with a cooler that offers leak-free expansion, the Eisbaer 240 is an excellent option.

ANTONY LEATHER

The 30mm-thick radiator appears to be identical to an Alphacool NexXos ST radiator

INTEL LGA115X



LGA115x

COOLING
35/40

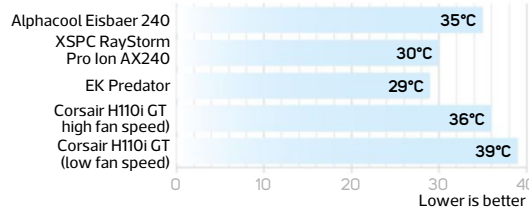
DESIGN
25/30

VALUE
27/30

OVERALL SCORE

87%

INTEL LGA2011



LGA2011

COOLING
33/40

DESIGN
25/30

VALUE
26/30

OVERALL SCORE

84%

VERDICT

A great introduction to expandable water cooling, with a cooler that's powerful, quiet and affordable.



Performance without compromise



Spectre Lite

- AMD FX-4300
- ASUS® M5A97 R2.0
- 8GB HyperX FURY RAM
- 2GB NVIDIA® GeForce® GTX 950
- 1TB Hard Drive
- Corsair 350W PSU
- **Windows 10**
- 3 Year Standard Warranty

THIS SPEC FROM

£499*



Gladius 900

- Intel® Core™ i5-6600K
- ASUS® Maximus VIII Hero
- 8GB HyperX FURY RAM
- 2GB NVIDIA® GeForce® GTX 960
- 1TB Hard Drive
- Corsair 450W PSU
- **Windows 10**
- 3 Year Standard Warranty

THIS SPEC FROM

£899*



Vitrum

- Intel® Core™ i5-6600K
- ASUS® Z170-E
- 16GB HyperX FURY RAM
- 4GB NVIDIA® GeForce® GTX 970
- 400GB Intel® 750 PCIe SSD
- 1TB Hard Drive
- **Windows 10**
- 3 Years Warranty

THIS SPEC FROM

£1,199*



Glacier

- OC Intel® Core™ i7-6700K
- ASUS® Maximus VIII Hero
- 16GB Corsair Vengeance RAM
- 6GB NVIDIA® GeForce™ GTX980Ti
- 400GB Intel® 750 PCIe SSD
- 2TB Hard Drive
- **Windows 10**
- 3 Years Warranty

THIS SPEC FROM

£1,799*



14" Enigma VI

- Intel® Core™ M CPUs
- Intel Integrate Graphics
- Ultra thin: Just 15.6mm!
- Full HD IPS Screen
- Up to 7.5 Hours Battery
- Wireless as standard
- **Windows 10**
- 3 Year Standard Warranty

THIS SPEC FROM

£409*



15.6" Octane II

- 6th Gen Intel® Core™ CPUs
- NVIDIA® GeForce™ Graphics
- NVIDIA® G-SYNC™ Option
- Full HD IPS Screen
- Thunderbolt™ 3
- Wireless as standard
- **Windows 10**
- 3 Year Standard Warranty

THIS SPEC FROM

£1,119*

Order your system now with PC Specialist



/pcspecialist



@pcspecialist

Some features require Windows 8.1. Update available through Windows Store. Internet access required; fees may apply. Microsoft, and Windows are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries.

* Prices are including VAT and are correct at the time of printing, but subject to change.



Award winning custom PC & Laptop manufacturer

UNLEASH THE GAMER WITHIN **YOU...**



Vulcan 440

- Overclocked Intel® Core™ i7-4790K
- ASUS® Maximus VII Ranger
- 16GB HyperX FURY RAM
- 4GB NVIDIA® GeForce® GTX 980
- 500GB Samsung EVO 850 SSD
- 2TB Hard Drive
- Windows 10
- 3 Year Standard Warranty

THIS SPEC
FROM

£1,499*

Quality builds at a low price
Always

GET A FURTHER £15 OFF WITH THIS EXCLUSIVE VOUCHER CODE:

CPC15

ORDER ONLINE NOW

0333 011 7000

www.pcspecialist.co.uk



LOUNGE GAMING DEVICE

Roccat Sova / **£120** inc VAT (membrane keyboard), **£160** inc VAT (mechanical keyboard)

SUPPLIER www.amazon.co.uk

Gaming on the PC is still a hugely popular pastime, but most PC gamers are still confined to their desks. With the demise of Windows Media Center in Windows 10, it looked like lounge PCs were going the way of the dodo, but several peripheral manufacturers are trying to make the sofa a more PC gaming-friendly place, and one of them is Roccat with its new Sova.

We describe the Sova as a lounge gaming device – it's akin to a small desk that sits on your lap, providing an easy way of using a keyboard and mouse while you're sitting on a sofa. It's an identical concept to Corsair's Lapdog, but the latter didn't fare too well in practice. The Sova isn't as wide as the Lapdog but, like Corsair's equivalent, it includes

a padded underside that's fairly comfortable. Unlike the Lapdog, though, the Sova has a large wrist support area and a curved edge, which makes it instantly more pleasant to use.

The main reason for the Sova's smaller width is the built-in mini keyboard. It includes more keys than a tenkeyless keyboard (which usually omits the numeric keypad area), but it's much smaller than a full-sized keyboard, allowing the Sova to offer the same mouse mat area as Corsair's Lapdog, despite the reduction in width. Two keyboard options are available too – one with a membrane keyboard and one with mechanical switches (designed to act like Cherry's MX Brown models), priced at £120 and £160 respectively.

Roccat also claims that the pads underneath the Sova, plus the mouse mat and wrist area, will be replaceable, both for cleaning and replacing with optional upgrades, such as a cloth mouse mat, although there are no plans for a left-handed option of the Sova. Unlike the Lapdog, there's no connection for mains power either – just a 2-port, 4m detachable USB cable that caters for the keyboard and a 2-port hub on the underside for a mouse and headset.

The keys on both models are backlit with five-level blue lighting, but otherwise, they're no-frills affairs, with no

dedicated macro buttons or media switches. We used the mechanical version of the Sova, with the switches attempting to mimic Cherry MX Browns, but the Sova doesn't quite get there. The action feels a little spongy, and on closer inspection, we saw that slow key presses weren't actuating as precisely as the equivalent Cherry switches. However, this slight difference didn't translate into any missed key presses during general typing. The mechanical switches also feel much more pleasant and precise to press than a membrane keyboard.

Conclusion

The Roccat Sova is a decent platform for PC gaming from your sofa. The lack of a full-sized keyboard may put off some people, but it's unlikely to impact the casual gamer, although notably, the Sova also lacks dedicated macro and media keys. However, Roccat has practically nailed the comfort aspect that was missing from the Lapdog, and the promise of swap-out mouse mats and wrist rests is encouraging too. It's still a little pricey, especially as you're not getting real Cherry MX switches, and the asking price for the membrane version feels a little steep too. However, if you're keen on gaming in your lounge, the Sova is much more comfortable to use than the Corsair Lapdog.

ANTHONY LEATHER

The keys are backlit with five-level blue lighting

DESIGN
35/40

FEATURES
24/30

VALUE
23/30

OVERALL SCORE
82%

VERDICT

A tad expensive, especially without proper Cherry switches, but the Sova is comfortable to use and ideal for sofa gaming.



cube

DESIGN YOUR ULTIMATE CUSTOM PC

Box Limited recommends Windows

Home

Windows 10

Microsoft



CASE



IN WIN

CORSAIR GAMING



CPU



GRAPHICS



msi



STORAGE



HYPERX

Seagate SSHD



+ RAM, COOLING, MOTHERBOARD & MORE

YOUR PC - YOUR CHOICE - DEFINE YOUR DESTINY!

Configure yours now at box.co.uk/custom

LATEST GEFORCE® GTX 1070/1080 VR READY GAMING PCs

Cube Tension VR



- MSI GeForce® GTX 1070 8GB
- Intel Core i5 6600K 3.5GHz
- **Windows 10**
- 16GB **DDR4** HyperX RAM
- 480GB SSD + 1TB SSHD
- 2 Year Warranty

GEFORCE GTX
VRREADY

From **£1399***

Cube Minotaur X99



- MSI GeForce® GTX 1080 8GB
- Intel Core i7 6800K 3.4GHz
- **Windows 10**
- 16GB **DDR4** 3000MHz RAM
- 240GB SSD + 2TB SSHD
- 2 Year Warranty

GEFORCE GTX
VRREADY

From **£1899***

Cube Leviathan SLI



- 2x MSI GeForce® GTX 1080 8GB SLI
- Intel Core i7 6700K 4GHz
- **Windows 10**
- 16GB **DDR4** HyperX RAM
- 240GB SSD + 1TB SSHD
- 2 Year Warranty

GEFORCE GTX
VRREADY

Only **£2449***

Buy online at www.box.co.uk Or visit our Birmingham Store



*Prices & offers are correct at time of going to press and are subject to change without notice. Nothing in this advert forms part of any contract. Prices are inclusive of VAT at the current rate of 20%. Box.co.uk is a trading name of Box Limited.

Custom Kit

Paul Goodhead checks out the latest gadgets, gizmos and geek toys



FITNESS TRACKER

Misfit Ray / **£79 inc VAT**

The minimalist, brushed aluminium shell of the Ray is miles away from the usual rubberised, brightly coloured fitness trackers. Designed to target the casual crowd, it's refreshingly simple to use; just fit the removable batteries (which last six months), pair it with a phone and you're off. With no external buttons or screen on the tracker itself, the app offers the only way to see your daily stats, however, so it's a good job that it's intuitive to navigate and use. It's an entry-level device, so there's no GPS or heart rate tracking, but if you just want to generally track your activity from day to day, or measure how well you're sleeping, it works well and fits easily into your everyday lifestyle.



SUPPLIER www.misfit.com



CAR ACCERSSORY

Tyre Pilot STP1400 / **£80 inc VAT**

The STP1400's four smart tyre caps monitor your tyre pressure and sound the alarm if any readings stray above or below pre-defined safe levels. The four caps connect wirelessly to a neat central LCD that fits into a lighter socket and shows all four of the tyre pressure readings. The display can be set to Bar or PSI, and this central unit beeps insistently if any of the settings go awry. The system worked flawlessly during our tests, recognising when we removed a cap and accurately reporting back to the central console. The only negative is that the batteries in the caps need to be replaced every year, and doing so is a fiddly process to say the least.



SUPPLIER www.snooper.co.uk

COASTER SET

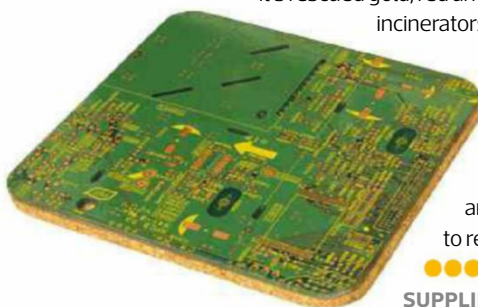
Revolve PCB coasters
(set of four) / **£13 inc VAT**

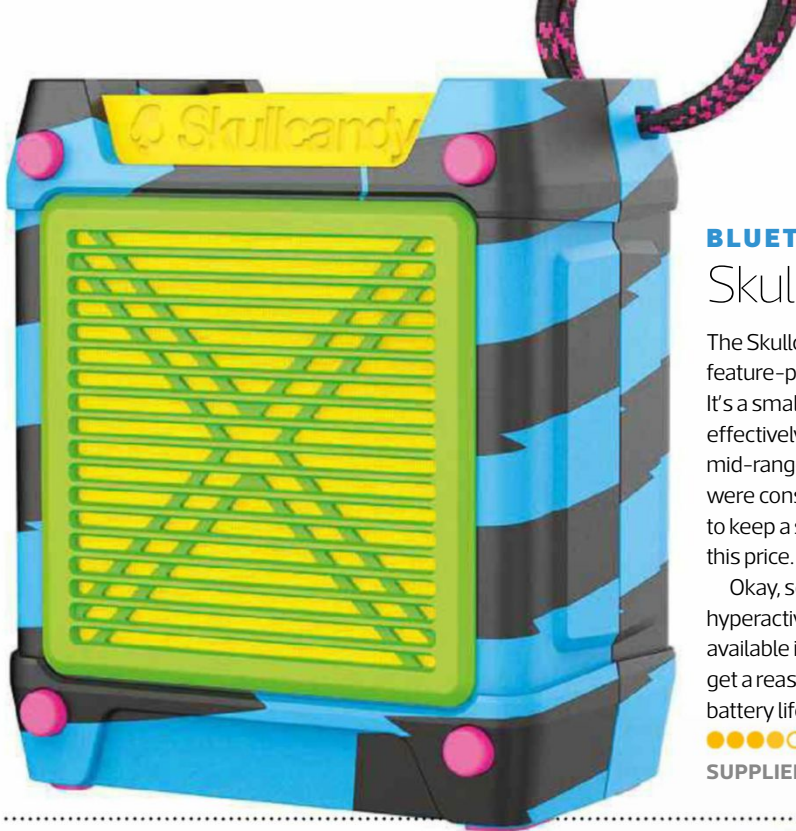
We think PCBs are beautiful, and Huddersfield-based Revolve agrees. The firm creates all manner of items from reclaimed PCBs, such as the four-piece coaster set here. Each mat has a sturdy PCB top, backed with grippy cork to prevent any slips or mishaps, and they do a good job of lending a coffee table a subtle, sophisticated edge of tech chic.

The colour you receive is down to luck though – Revolve claims it's rescued gold, red and even blue PCBs from incinerators in the past, so there's no guarantee your good will match your furnishings. However, if that isn't an issue for you, these coasters are great-looking and functional, plus they help to reduce tech industry waste.



SUPPLIER www.revolve-uk.com





BLUETOOTH SPEAKER

Skullcandy Shrapnel / **£22 inc VAT**

The Skullcandy Shrapnel is a pleasant antidote to the increasingly feature-packed and expensive Bluetooth speakers you often see. It's a small box that blasts out your favourite music cheaply and effectively; do you need much more? Bass output is passable, while mid-range tones are well produced. The very highest frequencies were conspicuously absent, but the overall effect is still good enough to keep a small group of people entertained outdoors, especially at this price.

Okay, so the colour scheme looks like it was created by a hyperactive four-year-old in Microsoft Paint, but the speaker is also available in plain black for folks with more conservative tastes. You get a reasonable sound for a good price, though, and the ten hours of battery life is good too.



SUPPLIER www.amazon.co.uk

JIGSAW

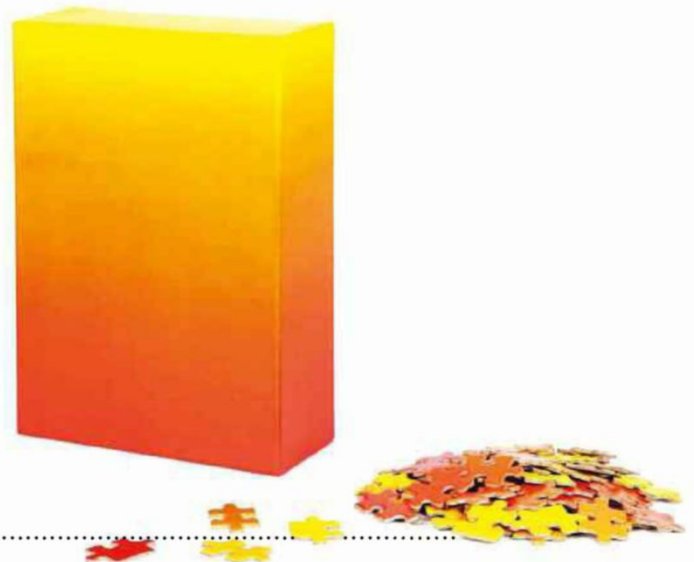
Gradient Puzzle / **£17 inc VAT**

We thought this puzzle would be simple. After all, it's just colours, right? It has to be easier than desperately searching for another piece of cloud or grass in a normal jigsaw. Little did we know how about the arguments that could ignite over a piece's exact shade of red.

Made of 500 pieces, the Gradient Puzzle tested our eyes to the point where we could only work on it for so long before we had to step away and have a calming cup of tea. The issue is exacerbated by the fact that all the central pieces are the same shape, so there's little certainty about whether you've got a piece right or wrong. Still, once assembled, the end image is quite beautiful – it was a wrench to break it up.



SUPPLIER www.firebox.com



ROUTER

BT SmartHub / **FREE** (new BT customers),
£50 inc VAT (other BT customers) / **£130 inc VAT**

Free ISP routers rarely have a good reputation, but BT's Smart Hub looks set to change that. New BT customers will get the Smart Hub for free, and current customers can upgrade for £50, which is good value when you consider the massive improvement the Smart Hub offers over the Home Hub 5 it replaces.

It has more antennae (seven, in fact), and while both routers are dual-band, 802.11ac models, the Smart Hub uses the latest version of 802.11ac dubbed 'wave 2'. The result is that the Smart Hub leaves the Home Hub in the dust. Transfer speeds peaked at 28.7MB/sec at short range on the 5GHz band – just shy of a 50 per cent improvement, and the range on the 2.4GHz band was dramatically better, rendering a Wi-Fi extender in use at our test house effectively redundant. The settings menu could be less locked down, but that's a fault that can be overlooked when you get this router's performance.



SUPPLIER www.bt.com



Seen something worthy of appearing in Custom Kit? Send your suggestions to paul_goodhead@dennis.co.uk

SUBSCRIBE NOW!



Subscribe to **Custom PC** today
and save on the single issue price.

Each issue of **Custom PC** will be delivered directly to
your device each month.

SEE NEXT PAGE FOR SET-UP INSTRUCTIONS

▶ HOW TO SUBSCRIBE...

...on an iPad or iPhone

- STEP 1** Return to the *Custom PC* library
- STEP 2** Choose your subscription term and tap twice on the 'price' box
- STEP 3** Choose whether to create an optional PixelMags account
- STEP 4** Enter your Apple ID password to confirm



...on a Kindle Fire

Kindle Fire subscriptions come with a **FREE** one month trial.

- STEP 1** Tap 'Free Trial Subscription' in the *Custom PC* library
- STEP 2** Choose your subscription term from the drop down menu on the popup that appears
- STEP 3** Tap 'Subscribe'




...on an Android device

- STEP 1** Open the Google Play Store homepage and navigate to the Newsstand section using the tabs at the top
- STEP 2** Search for *Custom PC* using the search icon in the top right of the screen
- STEP 3** Click the 'Subscribe' button and pick your term
- STEP 4** Enter your Google password to confirm



...via the app

- STEP 1** Search for *Custom PC* via the search box in the Shop tab
- STEP 2** Tap the 'Subscribe' button
- STEP 3** Choose whether to create an optional  account
- STEP 4** Enter your Apple ID password to confirm



**Subscribe to *Custom PC* today and
save on the single issue price**

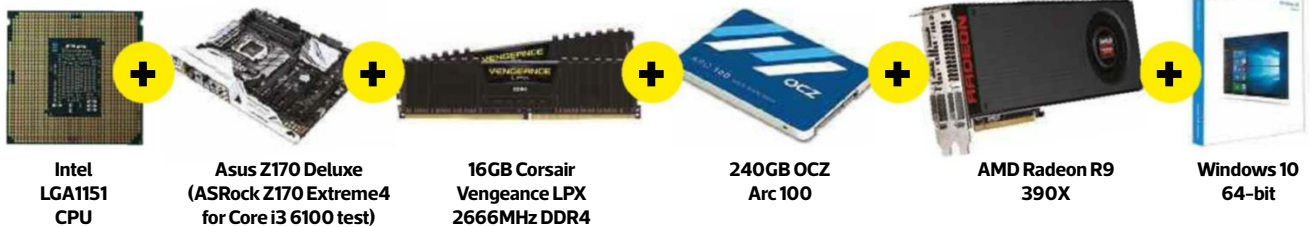
How we test

Thorough testing and research is the key to evaluating whether a product is worth buying, and deciding whether or not there's a better alternative

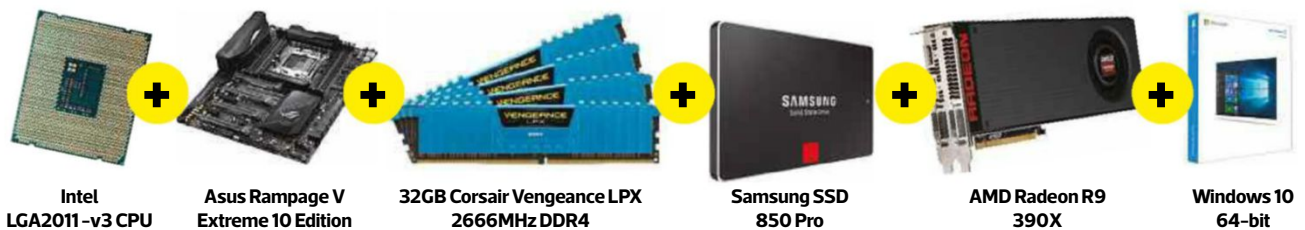
PROCESSORS

We judge CPUs on whether they offer sufficient speed for the price. Part of a CPU's speed score comes from how overclockable it is. Every type of CPU is tested in the same PC, so all results are directly comparable.

INTEL LGA1151



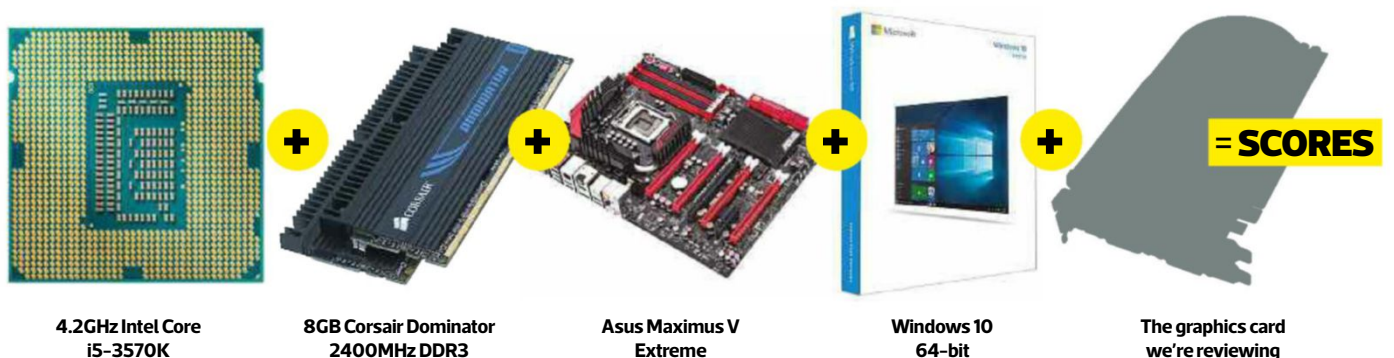
INTEL LGA2011-V3



TESTS: We use Custom PC RealBench 2015, Cinebench R11.5 and a variety of games. We also test the power draw of the test PC with the CPU installed. These tests reveal a broad range of performance characteristics, from image editing to gaming and video encoding to 3D rendering. We run all tests at stock speed and again when overclocked to its highest frequency.

GRAPHICS CARDS

Graphics cards are mainly evaluated on how fast they are for their price. However, we also consider the efficacy and quietness of the cooler. Every graphics card is tested in the same PC, so all results are directly comparable.



CUSTOM PC REALBENCH 2015

INTEL REFERENCE



AMD REFERENCE



Our benchmark suite, co-developed with Asus, simulates how people really use PCs – a higher score is better. You can download them from www.asus.com/campaign/Realbench

MOTHERBOARDS

Motherboards are evaluated on everything from layout and features to overclockability and value for money. Every motherboard is tested with the same components, so all results are directly comparable.

INTEL LGA1151



INTEL LGA2011-V3



TESTS: We use Custom PC RealBench 2015 and Total War: Warhammer, and also test the speeds of the board's SATA and M.2 ports. We try to overclock every motherboard we review by testing for a maximum base clock as well as overclocking the CPU to its maximum air-cooled level. We run our tests at stock speed and with the CPU overclocked.

The Awards



EXTREME ULTRA

Some products are gloriously over the top. These items of excellent overclock earn our Extreme Ultra award.



PREMIUM GRADE

Premium Grade products are utterly desirable – we'd eat nothing but beans until we could afford them.



PROFESSIONAL

Products worthy of the Professional award make you and your business appear even more awesome.



APPROVED

Approved products are those that do a great job for the money; they're the canny purchase for a great PC.



CUSTOM KIT

For those gadgets and gizmos that really impress us, or that we can't live without, there's the Custom Kit award.



TESTS: By using the fast PC detailed on the left, we can be sure that any limitations are due to the graphics card on test, rather than being CPU limited. We test Doom, Crysis 3, Fallout 4 and The Witcher 3: Wild Hunt at their maximum detail settings, in their highest DirectX mode, at several resolutions. High-end cards should be able to sustain playable frame rates at 2,560 x 1,440, while 1,920 x 1,080 is more important for mid-range cards; we also test at 3,840 x 2,160 for 4K monitors, and try to overclock every graphics card we test to assess the performance impact.

Wide eyes

Edward Chester goes beyond the standard widescreen panel and puts six immersive ultra-wide screens through their paces. If you fancy having a mini IMAX on your desk in front of you, we'll tell you which monitors are worth your cash



Contents

How we test / p41

Acer Predator X34 / p42

AOC C3583FQ / p43

AOC U3477PQU / p44

Asus ROG Swift PG348Q / p45

Philips Brilliance BDM3490UC / p46

Samsung S34E790C / p47

Results graphs / p48

How we test

In this Labs test, we're comparing the very largest, widest monitors you can buy. With diagonals measuring 34in across or greater, and with 21:9 aspect ratios, they're ideal for immersing yourself in movies and games. Many of these screens also include a gentle curve that helps to add to the sense of wraparound peripheral vision from these huge displays. A couple of models feature fast refresh rate panels, while some also have active sync tech for eliminating frame tearing and stutter, so of course, we'll be testing that too.

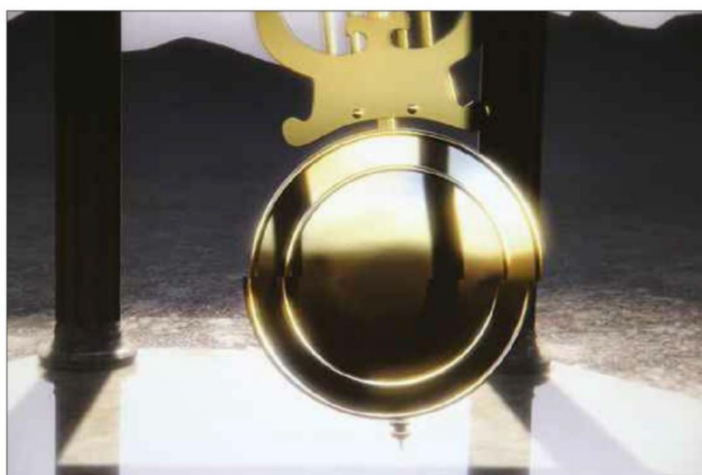
The first factor we consider is the design and build quality of the device. Does it look good on your desk and does it feel like it will stand the test of time? Not all the monitors on test here include a full range of ergonomic adjustments – height, rotation, tilt and pivot.

Next, we assess the connection options, looking for whether the display offers a good selection of display outputs and seeing what extras it has to offer, such as USB ports, headphone sockets and speakers.

Also taken into consideration is the on-screen display (OSD) and the controls used to navigate them. Some monitors offer a clear menu system with a set of controls that are easy to locate and use, while others may suffer from unintuitive controls and an overly complicated or spartan set of options.



We take the on-screen display (OSD) menus into account, plus the controls used to navigate them



Some displays feature active sync tech, such as G-Sync, to reduce tearing, as seen in the middle of this pendulum

Then we move on to assessing image quality, using a selection of subjective and objective tests, the latter conducted with an X-Rite i1 Display Pro colorimeter. First of all, we reset each display to its default mode, and then assess it exactly as it would behave straight out of the box. Nearly all monitors arrive with the brightness set too high for daily use, but that's an easy fix for most users.

We're more concerned with whether the default colour modes and settings for areas such as contrast and sharpness offer a good out-of-the-box experience.

We then tweak some of the more obvious settings to see if it's easy to get the display looking right without resorting to using a colorimeter. Only then do we dive deep into the settings to set up the display as optimally as possible, testing it with a colorimeter along the way. This process is conducted with the monitor set to a standard brightness of 120 nits, which is the normal setting we'd suggest for daily use.

We look for the colour temperature – a measure of whether the colour balance is correct – which should be at the industry standard of 6500K. Any result within about 500K of this figure is acceptable – with a result much below that number the display will look obviously yellow-tinged, while a result above that figure will look too blue.

We also assess the colour gamut, which is the percentage of the standard sRGB and AdobeRGB colour palettes. The former is



Objective image quality tests are conducted with an Xrite i1 Display Pro colorimeter

the standard for computing while the latter is only really needed if you work in printing, perhaps as a professional photographer or publisher. Any result above 90 per cent sRGB is decent, while the closer to 100 per cent the better.

Next is the delta E, which refers to the display's ability to pick out fine gradations in

colour – the lower the number, the better. Any result below 3 is decent, while the very best 10-bit panels will get below 0.1.

Viewing angles are also important, which is an area where TN monitors have traditionally suffered. Viewed head on they look fine, but if you move around, or if the display is really big, you'll see colour and contrast changes, particularly at the edges. IPS, PLS, VA and other technologies largely don't suffer from these problems.

Finally, we play plenty of games on these displays, and assess how well any gaming-specific technologies work. For example, we'll test whether high refresh rate panels look and feel as fast as claimed, and if any adaptive sync features (FreeSync or G-Sync) work as stated.

The scores are derived from a combination of image quality – based on a combination of the subjective and objective tests, features and value, adding the three scores together to get the overall result. We consider adaptive sync technology to be a feature, rather than an image quality factor.

Acer Predator X34 / £950 inc VAT

SUPPLIER www.overclockers.co.uk

As with our recent 27in monitor shootout (see Issue 155, p44), it's Acer and Asus that lead the pack with the most expensive monitors on test. Both models cost the best part of £1,000, as well as offering a 100Hz refresh rate, G-Sync support and a premium design, on top of the already great expense of a 34in curved IPS panel with a 3,440 x 1,440 resolution. On paper, they're simply the ultimate gaming monitors you can buy right now.

As you would expect for the money, the Acer Predator X34 is everything you could want from a monitor that costs £950. Its design, for instance, is first-class. The striking angular stand looks aggressive yet elegant, with the solid metal legs tapering to fine points. What's more, the display's front pane of plastic extends over the bezels, creating the illusion that they're super-thin.

Around the back you'll find a huge expanse of glossy plastic, which does pick up dust and fingerprints but otherwise looks good, and there are a couple of angled sections incorporating the ventilation grilles and video inputs. A few flashes of red hint at classic 'gamer' styling, but it's otherwise it's a classy display. The other nod towards gamer styling is the underside's row of nine LEDs, which shine down onto your desk, allowing you to cast light of your chosen colour across your work space. It's a largely frivolous addition, but it does make the monitor look good.

Meanwhile, the stand includes a handle at the top for easy carrying, and a loop at the bottom through which you can poke your cables to keep them tidy. It also offers height, tilt and rotation adjustment, so it's easy to get this display set up and pointing in the right direction.

Sadly, as the Predator X34 is a G-Sync display, connection options are limited to just one DisplayPort input and one HDMI connector. It has a four-port USB 3 hub too, but all the sockets are at the back, with none conveniently located on the side. Similarly, the



Engage G-Sync, fire up a few games and this display is an utter joy to use

X34's menu system needs some work. The buttons on the underside of the panel line up neatly with the on-screen menus, but the overall layout and navigation system isn't all that intuitive. It isn't awful, but it's an area where the Asus ROG Swift PG348Q (see p45) has the upper hand.

Thankfully, when it comes to image quality, the X34 is as good as you'd hope for its price. Its IPS-type panel (technically it's MHVA, a clone of IPS) produces the excellent viewing angles you'd expect, along with a solid >1000:1 contrast ratio. Combine these results with its ability to produce accurate colours and you have a display that excels for just about any use.

Out of the box it's not quite spot on, with colour temperature a touch high, although jumping into the User colour mode and dropping the blue channel a few notches soon sorted that out. Otherwise, all that's needed to get up and running is to drop

the brightness down from its default 80/100 level to around half of that, and to enable overclocking so that you can push the display from its default 60Hz max to 100Hz.

Engage G-Sync, fire up a few games and this display is an utter joy to use. The huge, ultra-wide panel fills your vision, and the slight curve serves to create an ideal little bit of a surround effect.

These high-speed IPS panels can't quite compete with the fastest TN models, of course, but with a 4ms response time and a 100Hz refresh rate, the X34 still offers a huge leap up in terms of responsiveness compared with 60Hz models. To top it all off, the X34's speakers offer a fairly deep, powerful sound, despite their diminutive size.

Conclusion

The Acer Predator X34 absolutely lives up to the performance you'd expect for such an expensive display. It looks good, has great image quality, gaming on it is fantastic and it has the extras you'd expect from a premium panel too. It's just a shame G-Sync pushes up the price so high.

IMAGE	FEATURES	VALUE
46/50	20/20	24/30

VERDICT

Great image quality and design with the bonus of G-Sync support, although it isn't cheap.

OVERALL SCORE
90%

AOC C3583FQ / £410 inc VAT

SUPPLIER www.scan.co.uk

The AOC C3583FQ is the only display on test with a diagonal that doesn't measure 34in from corner to corner – instead it measured 35in across! However, it couples this extra size with a comparatively low resolution of just 2,560 x 1,080 pixels, while raising the refresh rate to 160Hz.

The result is a display that feels much more like a cross between a monitor and a TV than a straight monitor. This hybrid feel is reflected in the design, which puts all the connections in the base, while the panel is kept clean and tidy – ideal for a living room-style arrangement where the back of the display is exposed.

That said, the C3583FQ isn't particularly stylish. It tries, with its tidy base, the shiny slender stand and the glossy expanse of the panel's back, but there's an obvious lack of quality. It's all made from plastic, with no super-slim bezels and, although the same is true of the Samsung S34E790C, the quality of the latter shines through. Next to a monitor such as the Philips BDM3490UC (see p46), the AOC C3583FQ clearly isn't of the same calibre in terms of build quality.

The stand doesn't offer much in the way of adjustment either, with just a tilt option on offer. That means you may have to shuffle the whole display around and stick a couple of books underneath it to get it set up properly. If you end up doing so, you'll also need to be careful not to accidentally bend and damage any of the connections; the proximity of the sockets to the surface on which the monitor is placed means it's easy to snag cables plugged into them.

You get a class-leading selection of ports though. The C3583FQ is the only display on test with two DisplayPort inputs, plus it has two HDMI ports, a DVI input and a VGA connector. An audio input and output are also on offer, although there's no USB hub at all.



Setting up the display isn't all that simple, as the OSD controls are touch-sensitive and positioned on the base, which makes it difficult to watch what's on screen while hitting the right button. Thankfully, the out-of-the-box performance isn't too bad, though, so there isn't much to change. The main necessary tweak is switching from the Warm colour setting to the sRGB setting, which pulls the C3583FQ's colour temperature from 6236K to a far more accurate 6453K. Likewise, the gamma result then improves from 2.44 to 2.25.

The C3583FQ uses a VA panel type, specifically MVA. This technology lends this monitor excellent contrast, with it hitting 1824:1 out of the box and 1758:1 when calibrated. As a result, this display is great for watching video, as the deeper blacks and punchier colours add extra depth to the image.

Unfortunately, though, the C3583FQ isn't so accomplished when it comes to gaming. It's fine when running at 60Hz, but if you crank it up to 160Hz, it becomes clear that the MVA technology can't really cope with the refresh rate.

There's very obvious ghosting and smearing as the display fails to fully switch between one image and the next within the refresh rate required.

As a result, the C3583FQ simply doesn't feel fast and responsive in the way you would expect from a high refresh rate monitor. Combined with the low resolution, which makes your Windows desktop look far too large when you're doing normal work, as well as having obvious pixels, and you have a monitor that isn't particularly convincing.

Conclusion

The C3583FQ's fast refresh rate, size, connections, high contrast and low asking price all make it a tempting proposition, but a few key factors let it down.

Its low resolution just isn't practical for everyday computing on such a large display, while its high refresh rate performance isn't a patch on IPS and TN competitors. It has some appeal as TV/gaming hybrid display in front of a sofa, but there are better options for normal desktop use.

IMAGE	FEATURES	VALUE
35/50	18/20	24/30

VERDICT

Decent image quality and features for the price, but let down by a low resolution and ghosting.

OVERALL SCORE
77%

AOC U3477PQU / **£470** inc VATSUPPLIER www.currys.co.uk

AOC's U3477PQU is the only display on test not to offer a curved panel, and as such, it's one of the cheapest in this Labs test too. In fact, it's among the cheapest monitors you can buy with a 34in IPS panel and 3,440 x 1,440 resolution, but that doesn't mean it looks or feels cheap. It's still a stylish display with plenty of features and good image quality.

It all kicks off with a simple but effective physical design. The base sports fetching brushed metal with a clear plastic top, and the brushed effect is also seen on the back, though it's brushed black plastic here. It offers just the right balance between having a little style without being too outlandish or garish. It also has one of the new 'borderless' panels, where the front pane of plastic goes over the bezels, giving the appearance of super-slim bezels.

The simple silver stand offers height adjustment, tilt and rotation, plus you can also use this display in a portrait orientation. There probably aren't too many situations where you'd want to do so, but it moving the display into portrait mode does at least make it really easy to plug in your cables. One slight downside of the stand is that it attaches using a standard VESA attachment with four screws. That's great if you want to use an alternative stand, but it slows down the setup procedure compared with models with quick-release stands.

Meanwhile, the connection options on this display are good if not outstanding. Unlike G-Sync displays, you get more than one HDMI input and one DisplayPort socket, however the two extra connections are DVI and VGA, which are becoming less useful these days. You also get 3.5mm jack sockets for audio input and output, along with a USB hub, which sits on the right edge where it's easy to reach. It's slightly annoying that the input for the hub is also positioned on the side, as it makes it difficult to hide the cable, but it's better than the whole hub being less easy to reach.



You'll be pleased with the fantastic image quality if gaming isn't a top priority

Disappointingly, though, only two of the four ports are USB 3.

Like most of the displays on test, the areas in which this monitor trails the Acer and Asus are its lack of support for either FreeSync or G-Sync, and its slow refresh rate. These omissions immediately make the U3477PQU less appealing as a gaming display, but you'll be pleased with the fantastic image quality if gaming isn't a top priority for you.

Out of the box, the U3477PQU's colour temperature is a little warm and, as usual, it's overly bright, but switching from the Warm colour mode to Natural mode and dropping the brightness soon puts the display right. Once you've done that, you get a display that offers accurate colours, great contrast, great viewing angles and all the good quality you expect for an IPS display of this type.

We generally prefer curved displays when they

get to this size, but the U3477PQU is a good £150 cheaper than any curved equivalent, which makes its lack of a curved screen an acceptable compromise.

However, the final death knell for the U3477PQU being the ultimate low-cost option for gamers is that its input lag is too high. In our tests, it varied between 24ms and 50ms, with an average of 35ms. That result represents more than two whole refreshes of the display, making for a significant extra delay between your actions and seeing them on screen.

Conclusion

A fantastic low-cost entry into the world of high-quality, 34in, ultra-wide monitors. If gaming performance isn't a top priority, the AOC U3477PQU offers all the style, image quality and features you could want at a bargain price. However, high input lag and a lack of active sync tech means its gaming credentials are poor compared with other displays on test.

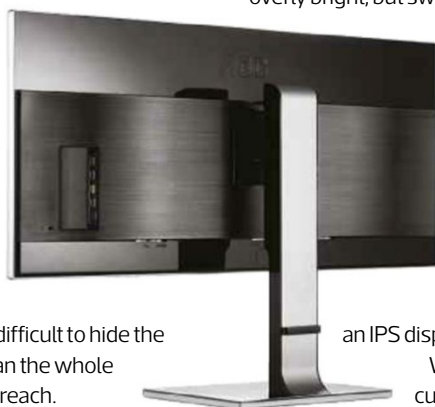
.....

IMAGE	FEATURES	VALUE
40/50	15/20	27/30

VERDICT

Stylish looks, solid image quality, a good feature set and a low price, but there are better gaming panels.

OVERALL SCORE
82%



Asus ROG Swift PG348Q / £1,000 inc VAT

SUPPLIER www.cclonline.com

A sus' ROG Swift PG348Q is currently sitting in our Elite list of top tech, but with us taking a look at the Acer Predator X34 and several other key competitors this month, it's time to reassess it. Let's start with the design, as it's probably the most divisive aspect of this screen. For the most part, the PG348Q's slim bezels and delicate tip-toe base gives it a slenderness that belies the sheer size of this display.

However, the faux brushed metal trim on the lower bezel, the copper highlights on the stand and the whacky design on the back, while not looking out and out gaudy, might be a bit over the top for some tastes. Then there's the light show. While the Acer has a subtle, colour-selectable glow, the Asus has a bright red Republic of Gamers logo that projects from underneath the stand onto your desk. It's definitely more striking, and as a result it's sure to appeal to some people more, but at the same time it may well put off others completely. Thankfully, it can be turned off.

As it's a G-Sync display, the connection options are just as limited as those of the Acer, with just a single DisplayPort input and one HDMI socket. You get a four-port USB 3 hub, which is useful, but all the connectors are pretty awkwardly placed on the back of the display, underneath a pull-off cover – hardly convenient for quickly plugging in a USB memory stick. Otherwise, though, this monitor's physical design is fantastic, with the stand offering smooth left/right rotation, height adjustment and tilt.

Of course, the big plus point for this monitor is its image quality, which is just as good as you would expect for the asking price. Right out of the box, the Asus nails just about every test, delivering an accurate colour temperature, good contrast and an impressive delta E of just 0.54, showing it can pick out the finest gradation in colour. You could absolutely get away with doing no tweaking to this display



Right out of the box,
the Asus PG348Q
nails just about
every test

other than dropping its brightness, which can't quite be said of the Acer.

Performing a full calibration, we had to drop the User colour mode from 100 x 100 x 100 (R x G x B) to 100 x 98 x 98 to get the colour temperature bang on, but otherwise it was ready to go without any tweaking. After running DispCal, the gamma improved to exactly 2.2 and colour coverage hit 99.6 per cent. Contrast dropped slightly to 954:1, as did the delta E (to 0.59), but the Asus is generally a fantastic display. The OSD control system, which is adjusted with a joystick on the back, is also much more intuitive than that of the Acer.

Then there's the 100Hz refresh rate and G-Sync support that put this monitor ahead of most of the competition. It arrives set to just 60Hz, so it's your job to unlock the 100Hz refresh rate by using the overclocking option in the display's menu. As such, we were intrigued to see if the overclocking

had any effect on image quality, and thankfully it didn't, with the display performing just as well at 60Hz or 100Hz.

Combine that extra speed with G-Sync support and that vast, wraparound panel, and you end up with a superb gaming experience. It does, of course, trail the 144Hz+ IPS panels you can get on some 27in displays, but 100Hz still offers a noticeable improvement in terms of responsive feel when compared to 60Hz.

Conclusion

The Asus ROG Swift PG348Q might be a monstrously expensive display, but it does have the performance to match. Image quality is fantastic, and its G-Sync support and high refresh rate make it superb for gaming.

It would arguably be a better deal with fewer gimmicks, such as the over-the-top light, and £100 knocked off the price, but the superb out-of-the-box image quality enables the Asus to justify its extra cost over the Acer. Add the otherwise cracking design and the PG348Q is the current king of this sector.



IMAGE 47/50 FEATURES 20/20 VALUE 23/30

VERDICT

A truly fantastic display that's arguably as good as you can get, although it's expensive.

OVERALL SCORE
90%

Philips Brilliance BDM3490UC / £629 inc VAT

SUPPLIER www.laptopsdirect.co.uk

The Philips BDM3490UC is the most obvious TV replacement-style monitor on test. It has a slick design that wouldn't look out of place in even the fanciest designer home, plus it has a large set of prominent speakers in the base. Sadly, though, the speakers aren't quite as impressive as you'd hope given their dominance of the design. They definitely have more power and depth than any of the other models on test but for a true cinema-on-your-desk experience, you'll want a better sound system.

Nonetheless, the Philips BDM3490UC remains a very stylish display. Its simple and glossy white back, slender solid metal stand and curved metal base gives it a real look of elegance.

It also has a so-called 'borderless' panel, with super-slim bezels. Even the ports on the back are lined up neatly to keep the whole unit looking as tidy as possible.

Aside from speakers the only aspect of the BDM3490UC's appearance that doesn't look quite right is the Philips logo that sits on a little metal tab below the screen. It serves as a useful anchor point for tilting the display though. Talking of adjustments, potentially the biggest compromise in terms of tweaking the stand is the lack of height adjustment and rotation. Only forwards and backwards tilt is available, and there's no option to remove the stand and use a VESA mount either.

Assuming you can find that ideal position, though, this display once again shows its multimedia chops with a fine selection of connection options. Joining its one DisplayPort input are three HDMI sockets. Only two of them support the display's full resolution, but it's convenient to have several HDMI inputs, perhaps to use for a games console, Sky box, Blu-ray player and so on. You also get audio input and headphone jacks, as well as a four-port USB 3 hub.



When it comes to setting up this display's picture, it uses a similar joystick-type control to Asus' displays. However, the experience of navigating through the menus isn't anywhere near as intuitive as Asus' efforts. Thankfully, the menus aren't too cluttered with extraneous options, and the single joystick button is at least hidden on the underside of the display, meaning there's one less object cluttering up that striking design.

On the plus side, you shouldn't have to use the OSD that much anyway, as there's very little that needs adjusting. Out of the box, the Philips Brilliance BDM3490UC has excellent overall image quality – as usual, the only tweak required was dropping the brightness down to a more sensible level.

Colour accuracy and coverage, as well as contrast and gamma, are all top-notch. Combine these great results with excellent

viewing angles, little to no backlight bleed and that huge, enveloping 34in curved panel, and the Brilliance BDM3490UC offers quite the visual experience.

As with the AOC U3477PQU, though, the key area where this display trails behind the Acer and Asus screens is in gaming. With

just a 60Hz refresh rate, fast-paced games lack the immediacy of models with faster

refresh rates. The lack of FreeSync or G-Sync support also means you'll also have to cope with some stutter or image tearing, unless your graphics card can consistently keep your frame rate at 60fps in time with VSync. However, while the AOC fell even further behind gaming panels thanks to its poor input lag, the Philips has no such issues. With an average input lag of just 10.7ms, there's no perceivable extra delay in fast-paced games.

Conclusion

The Philips Brilliance BDM3490UC is a great option for anyone seeking a stylish all-rounder of a display. It will happily sit and look pretty either on a desk or in the lounge, but it will also deliver the goods when it comes to overall image quality.

It's no gaming powerhouse, of course, but the Philips is a solid option that delivers image quality to match other top-notch 60Hz IPS panels.

IMAGE	FEATURES	VALUE
43/50	16/20	21/30

VERDICT

A great all-rounder with good looks and a decent image, although it isn't the best gaming monitor.

OVERALL SCORE
80%



Samsung S34E790C / £669 inc VAT

SUPPLIER www.debenhamsplus.com

The Samsung S34E790C is one of two monitors in this month's Labs test that doesn't use an IPS, or IPS-type display. Instead, it uses a VA panel that should provide it with a far higher contrast level than most other screens on test, making it potentially ideal for watching video. Before making a mark with its image quality, though, this monitor impresses elsewhere. It has a subtle, business-like style that marries a simple but elegant layout.

The base that cleverly follows the same curve as the screen, with just the right balance of black and silver, and this finesse continues around the back, with a fetching brushed finish to the black plastic. Unlike the Philips Brilliance BDM3490UC, though, the ports aren't neatly arranged in symmetrical rows.

The array of connections includes one DisplayPort input and two HDMI sockets, so it's better equipped than some of the other displays on test, particularly those with G-Sync support. These video connections are joined by four USB 3 ports and an audio output for piping out sound to external speakers or headphones.

Meanwhile, the stand's flexibility rises above many others thanks to the inclusion of height adjustment, plus it can tilt up and down. However, it can't be rotated left or right, which is a strange omission. One area where this display trails much of the competition, though, is in not having a 'borderless' panel. Instead, its otherwise impressively narrow bezels sit above the surface of the panel. In fact, Samsung has slipped up a little here by making these bezels shiny, rather than matt, so they can be prone to catching the light in if it's not sitting in a fully darkened room.

Firing up the display immediately reveals the advantages and disadvantages of VA and IPS panels. The Samsung has an obviously



narrower viewing angle, with slight contrast drops and colour shifts visible when your eyes aren't all that far off the centre, although it's still markedly better than your average TN panel in this respect. IPS panels generally offer a much wider viewing angle, until you go too far and IPS glow comes into play.

On the flipside, the S34E790C has visibly better contrast than the IPS screens on test. There's a real sense of dynamism to its picture, with blacks looking just that bit deeper, and brighter colours shining through. This perception is backed up by our test equipment; the Samsung initially scores a whopping contrast ratio of 2,112:1 – essentially double the result of any IPS screen on test.

What's more, the Samsung lacks for little in most other tests too, providing good overall colour coverage, accurate colour temperature and spot on gamma. It's only when distinguishing the finest differences in colour that the S34E790C trails its IPS rivals, with a delta E of 1.38.

Any result under 3 is okay here, but the best monitors in this Labs test get closer to 0.5.

Getting the absolute best results from this monitor did require jumping into the OSD menus to slightly tweak the manual colour options, and drop the brightness, but largely, it arrives good to go. Regardless, the menus are

easy to use, thanks to the rear-mounted joystick control and intuitive menu layout.

The upshot of all these great results is that this display is fantastic for watching video, in particular. The picture ends up with much more depth than an IPS panel – the latter can look a touch washed-out in comparison. As the Samsung is only a 60Hz display, competitive gaming isn't its main focus, but games still look great on it, and the input lag of 10.9ms doesn't impose any delays over and above that 60Hz refresh rate.

Conclusion

With a standard 60Hz refresh rate and no active sync tech, the S34E790C isn't the last word in high-speed gaming, but its overall excellent image quality and particularly impressive contrast from its VA panel makes it ideal for anyone interested in watching video. The main compromise here is the narrower viewing angle of VA panels compared with the lower contrast of IPS rivals.

.....

IMAGE	FEATURES	VALUE
47/50	16/20	22/30

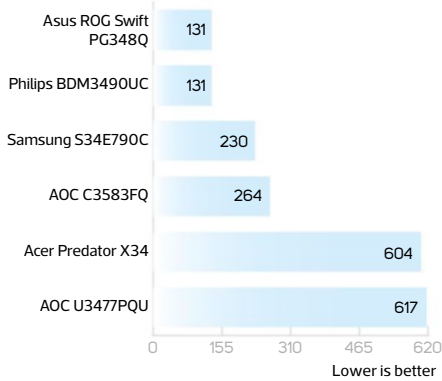
VERDICT

High contrast makes this display fantastic for video, but the trade-off is a narrower viewing angle.

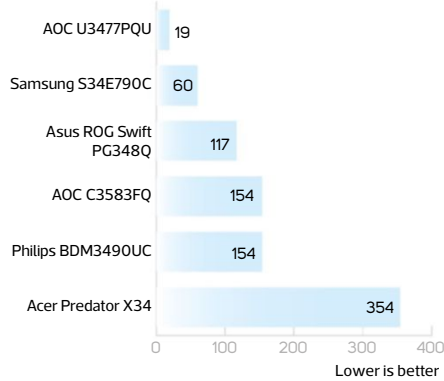
OVERALL SCORE
85%



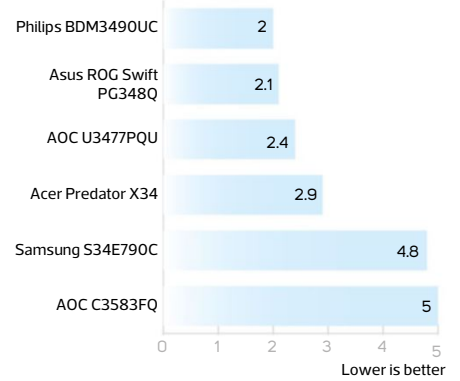
UNCALIBRATED COLOUR TEMPERATURE (KELVIN)
Deviation from ideal result (6500K)



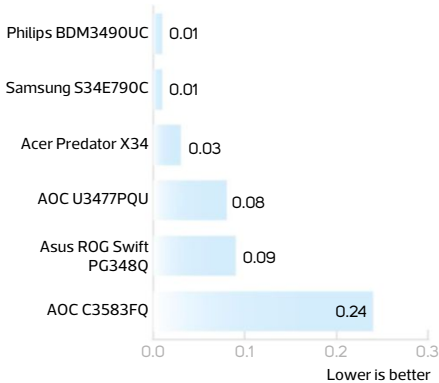
CALIBRATED COLOUR TEMPERATURE (KELVIN)
Deviation from ideal result (6500K)



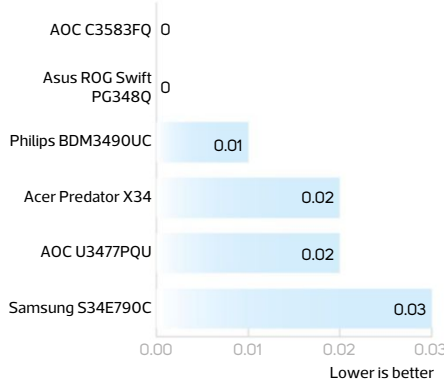
BRIGHTNESS UNIFORMITY (AVERAGE PER CENT)
Mean deviation



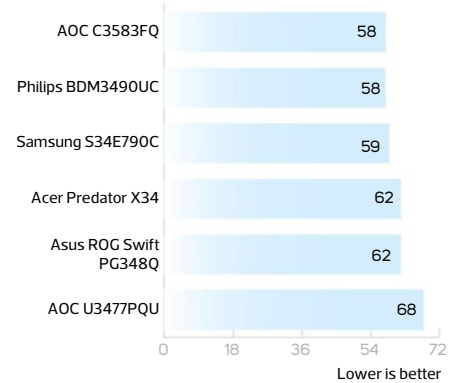
UNCALIBRATED AVERAGE GAMMA
Deviation from ideal result (2.2)



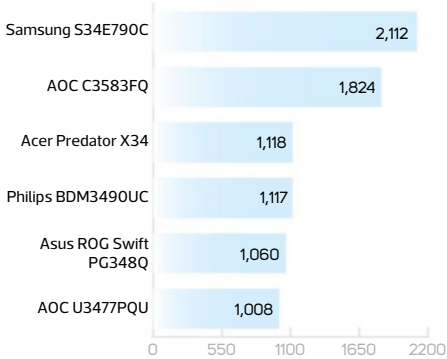
CALIBRATED AVERAGE GAMMA
Deviation from ideal result (2.2)



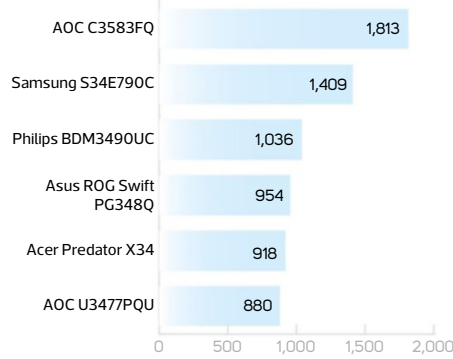
POWER CONSUMPTION (WATTS)
White screen at max brightness



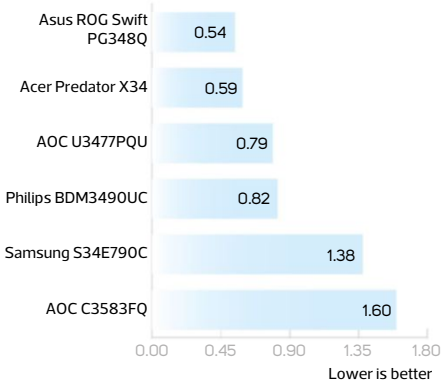
UNCALIBRATED CONTRAST RATIO
Ratio of white-to-black luminance



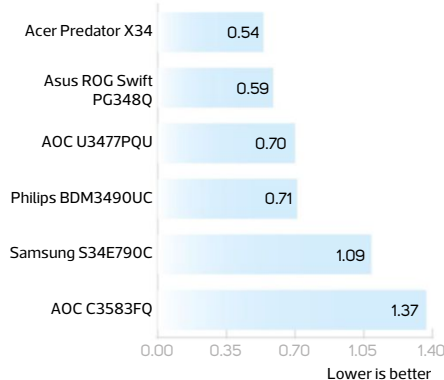
CALIBRATED CONTRAST RATIO
Ratio of white-to-black luminance



UNCALIBRATED COLOUR ACCURACY
Average delta E 2000



CALIBRATED COLOUR ACCURACY
Average delta E 2000



The Sun-worshiper



The Weekender



The Explorer



The Adventurer



Whether you'll be sitting on a beach or going on an adventure this summer, we have a magazine for you in our **SUMMER SALE!** **SAVE UP TO 50%** and receive a **FREE** portable speaker – the perfect companion to any summer read



magazinedeals.co.uk/summersale



01795 592 910 quote code: **P1610PSC**



*Gifts limited to the first 1000 orders only. Please allow 28 days for delivery. UK only offer. Alternative gift may be supplied

Small but mighty

If you want a small, powerful system, but with more upgrade room than a mini-ITX PC, then you want a micro-ATX rig. Antony Leather selects some of the latest micro-ATX cases, and some old favourites, to see which ones deserves your cash

Contents

Cooltek UMX3 / p51

Corsair Obsidian 350D / p52

Fractal Design Arc Mini R2 / p53

Phanteks Enthoo Evolv MATX / p54

Raijintek Styx / p55

SilverStone Kublai KL06 / p56

Results graphs / p57

How we test

Our trusty micro-ATX case test gear includes an Intel Core i7-875K overclocked to 3.4GHz with a 1.175V vcore and 1.86V CPU PLL, plus a Sapphire Radeon HD 5770 graphics card. The kit is installed into a Gigabyte GA-H55M0UD2R motherboard with 2GB of PNY DDR3 memory, a Corsair Force GT SSD and Seasonic M12D DD-850EM PSU. This kit might be a few years old now, but it's ideal for testing the thermal performance of a case.

The CPU cooler is a fairly modest Gelid Tranquillo, but with the fan replaced with a slow-spinning Noctua NF-S12B ULN, in order to highlight the poorest and best-performing cases. The graphics card's

cooler also dishes heat into the case, as well as through a rear vent – similar to most modern third-party coolers. We lock this cooler's fan speed at 30 per cent to prevent automatic fan control from interfering with the results.

We leave each case for 15 minutes running Prime95 v26.6's smallfft test (www.mersenneforum.org) to load the CPU, and Unigine's Heaven benchmark (<https://unigine.com/products/heaven>) to load the GPU. Temperature results are taken from CoreTemp for the CPU (www.alcpu.com/CoreTemp) and GPU-Z for the GPU (www.techpowerup.com/gpuz). We then subtract the ambient temperature from the results to give a delta T reading.

We also use a sound meter to help gauge the noise each case makes so we can comment objectively in the reviews.

We test cases in their standard configuration with the fans included in the box; adding more fans will improve airflow, but will cost you more money. However, where appropriate, we adjust the positions of fans and drive bays to obtain the best cooling a case can offer out of the box, as well as using available fan controllers to identify the best balance between noise and cooling.

We score each case using weighted calculations for their cooling, design, features and value, which are then added together to give an overall score.



Cooltek UMX3 / £119 inc VAT

SUPPLIER www.quietpc.com

Many of the cases on test this month are standard black towers, but the Cooltek UMX3 blows every other case out the water when it comes to style and build quality. It sports a sweeping aluminium exterior that can be paired with a borderless window panel for an extra £10, and it looks great. It's also extremely light, weighing just 4kg, and it's fairly compact, with all its dimensions measuring below 400mm, with a width of just 188mm wide.

Aside from a few front buttons and ports, and excluding the window option, there isn't much in terms of vents. There's just a single 140mm fan mount in the roof and one 120mm mount in the rear, both occupied out of the box and hooked up to a two-speed fan controller. There's no cooling in the front of the case, though, as that's where the PSU sits – like the Raijintek Styx (see p55), the UMX3 shifts the PSU mount in front of the motherboard. This arrangement solves one potential issue with the case, which is a lack of standard cable-tidying space.

There's no rear side panel, so all the cables are stored in the main chamber, but having the PSU's shifted location means it's fairly easy to gather all the cables together in close

proximity of the graphics card, storage mounts and motherboard. Like the Styx, the UMX3 uses an extension cable for the PSU, so you can plug in your mains lead around the back as normal.

Meanwhile, the two large vents in the base of the case both sport dust filters, and there are storage mounts above them. You get three dedicated 2.5in bays and a vibration-proof 3.5in mount too, although these mounts aren't tool-free. All these bays are removable, although there are no fan mounts in this location, so there isn't much potential for fitting a radiator here unless you're prepared to drill some holes. You'll need to remove the 2.5in drive cage if you want to install two graphics cards as well.

The cooling arrangement is a little odd as standard. The rear fan is set up as an intake, while the roof fan acts as a more usual exhaust. Switching the CPU cooler fan around accordingly, the CPU delta T of 54°C wasn't particularly inspiring, although the GPU delta T was a decent 49°C. We suspected that the rear fan would best serve as a second exhaust, though, so we moved the CPU cooler back to the front of the heatsink and switched the rear fan around. Sure enough, the CPU



delta T then fell by 2°C and the extra exhaust power saw the GPU delta T fall by 3°C. These results still aren't chart-topping temperatures, but the UMX3 is also one of the quietest cases on test. You'd be advised not to drop the fan speed to low with overclocked systems, though, as doing so added 7°C and 10°C to the CPU and GPU delta T respectively, although it was blissfully quiet at this setting.

Conclusion

Apart from lacking tool-free drive mounts, the Cooltek UMX3 ticks quite a few boxes. It has fan control, great looks, epic build quality and it's small too. Cooling isn't stellar, but it's acceptable and there's plenty of space for single-fan liquid coolers. The only problem is its comparably steep price, meaning cheaper cases offer better value for what you get, but it's a cracking case if you have the money.

COOLING	FEATURES	OVERALL SCORE
25/30	11/20	
DESIGN	VALUE	80%
29/30	15/20	

VERDICT

Better cooling and more features can be had for much less money, but the UMX3's fantastic aesthetics and build quality just about justify its price.

SPECIFICATIONS

Dimensions (mm) 188 x 358 x 365 (W x D x H)

Material Aluminium, steel

Available colours Black, silver

Weight 4.2kg

Front panel Power, reset, 2 x USB 3, 2 x USB 2, stereo, mic

Drive bays 1 x 3.5, 3 x 2.5in

Form factor(s) Micro-ATX, mini-ITX

Cooling 1 x 140mm roof fan mount (fan included), 1 x 120mm rear fan mount (fan included)

CPU cooler clearance 160mm

Maximum graphics card length 320mm



Corsair Obsidian 350D / £75 inc VAT

SUPPLIER www.scan.co.uk



An old-timer in our line up of micro-ATX cases this month, Corsair's premium Obsidian 350D tower put in an excellent performance in our last micro-ATX group test a couple of years ago, much like Fractal's Arc Mini R2 (opposite). It isn't as deep as the Arc Mini R2, so it looks a little more compact, although it's taller and noticeably larger than the Raijintek Styx and Cooltek UMX3.

Corsair's Obsidian range is showing its age against some newer cases, including the company's own new Carbide models such as the 400C. However, the 350D still has a lot to offer. The reduced depth means there's not quite enough room for a triple 120mm radiator but, unlike the Arc Mini R2, the 350D can support double 140mm-fan radiators in both the front and roof sections, if you're prepared to lose some drive mounts, so it matches the Fractal for water-cooling room. There's a reasonable amount of height above the motherboard, so a half-height radiator with a single row of fans won't obscure the board.

As standard, there's one 140mm front fan and one 120mm rear fan included, which is reasonable for the price, but like the Arc Mini R2, the 350D emphasises what you can add

to the case as well as what's in the box. There aren't quite as many storage bays as the Arc Mini R2, but the 350D includes two 5.25in bays and a trio of nifty removable tool-free 2.5in mounts. It's amazing that Corsair introduced these mounts a few years ago, yet many manufacturers still require you to screw your SSDs in place. There are two more 2.5in/3.5in tool-free bays in a removable cage at the bottom too, so you'll only be stuck for storage space if you take advantage of all the water-cooling options.

Meanwhile, build quality is solid rather than exceptional; it isn't quite as refined as some of the other cases on test and some parts can feel a little flimsy or clunky.

These are minor niggles though; the 350D is a £75 PC case that otherwise provides an excellent home for a range of system types. There's an ample 180mm of clearance for CPUs, 350mm for graphics cards and a decent amount of room behind the motherboard tray for tucking cables. The 350D topped the charts in performance tests too, with consistently good results for both the CPU and GPU delta Ts. The Arc Mini R2 matched the former, but only with its drive cages removed, and only the SilverStone

KL06 came close in terms of GPU cooling. However, the 350D is also one of the louder cases on test – if noise is a big concern, the Fractal will be a better bet.

Conclusion

There's little not to like about the Corsair Obsidian 350D. It offers good value for money, sports practically every notable feature except a fan hub and fan control, and provides plenty of room for water cooling. The Arc Mini R2 is the overall favourite, thanks to lower noise and fan control, but if cooling is your priority the Obsidian 350D should be at the top of your list.

COOLING	FEATURES	OVERALL SCORE
28/30	16/20	
DESIGN	VALUE	86%
23/30	19/20	

VERDICT

Despite being nearly three years old, the 350D is still an excellent micro-ATX chassis, especially if you're looking to water-cool your system.

/SPECIFICATIONS

Dimensions (mm) 210 x 450 x 440 (W x D x H)

Material Steel, plastic

Available colours Black

Weight 6kg

Front panel Power, reset, 2 x USB 3, stereo, mic

Drive bays 2 x external 5.25in, 2 x internal 3.5in, 3 x internal 2.5in

Form factor(s) Micro-ATX, mini-ITX

Cooling 2 x front 120/140mm fan mounts (1x fan included), 2 x top 120/140mm fan mounts (fans not included), 1 x 120mm rear fan mount (fan included)

CPU cooler clearance 180mm

Maximum graphics card length 350mm



Fractal Design Arc Mini R2 / £74 inc VAT

SUPPLIER www.cclonline.com

It's little surprise that Fractal Design's Arc Mini R2 hasn't changed in two years; it won our last micro-ATX group test in 2014 and it's done just as well this time, despite some new competition. It's certainly one of the larger cases on test – it's noticeably taller, wider and deeper than the Cooltek UMX3, and its depth of 484mm is akin to some ATX cases. However, Fractal has made excellent use of this space.

For starters, ventilation is far better than on Phanteks' Enthoo Evolv MATX (see p54), with open mesh vents in the roof and front with both of these and the base covered by dust filters. It isn't as attractive as the Phanteks, but the brushed metal look on the plastic fascia, plus the smooth lines and inset front grill help make the Fractal look appealing.

Despite being a micro-ATX case, the Arc Mini R2 is also fantastic for housing all-in-one liquid coolers and even full custom water cooling. The roof offers a pair of offset 140mm fan mounts and three 120mm fan mounts, with space for triple 120mm-fan radiators that should, thanks to the offset, clear most motherboards too. Removing the front drive cages also allows full-height double 120mm-fan radiators to be used, with a 275mm height limit if you want to keep the 5.25in mounting bracket at the top.

There's also a reasonable 165mm clearance for CPU coolers and an ample 400mm of space for graphics cards but only if you remove the top drive cage. Meanwhile, three case fans are included as standard – 120mm models in the rear and front, and a 140mm fan in the roof, plus the case includes a three-channel, three-speed fan controller.

There are plenty of storage options too. There's a pair of removable drive cages, each of which can support a trio of 2.5in or 3.5in drives, or a mixture of each, plus a further two 2.5in mounts behind the motherboard tray.

At full speed, the fans did a reasonable job of getting the CPU and GPU delta Ts under control, but the latter was 5°C warmer than in the Corsair 350D. This result rose by 7°C in quiet mode, and the CPU result rose by 5°C too, although this temperature is still far from a poor result. Removing the two drive cages improves airflow, with the Arc Mini R2 matching the Corsair case's CPU delta T and the GPU result being just 2°C warmer. What's more, the Fractal remained pleasingly quiet.

Conclusion

The Fractal Design Arc Mini R2 is a tad on the large side, so doesn't quite make the most of the smaller micro-ATX form factor. However,



it offers loads of cooling and storage options, it's quiet and it has useful features such as a fan controller. Cooling is excellent if you remove the drive cages, using the motherboard tray's rear to house a couple of SSDs instead, and its water-cooling support is fantastic. It lacks some pizzazz on the outside, and the Phanteks Evolv MATX and Cooltek UMX3 definitely look edgier, but at just £74, the Fractal is a great value all rounder.

COOLING	FEATURES	OVERALL SCORE 87%
27/30	19/20	
DESIGN	VALUE	
22/30	19/20	

VERDICT

It might be an old-timer, but the Arc Mini R2 is still able to claim the micro-ATX crown, offering great versatility, good cooling and quiet operation.



SPECIFICATIONS

Dimensions (mm) 210 x 484 x 405 (W x D x H)

Material Steel, plastic

Available colours Black

Weight 9kg

Front panel Power, reset, fan control switch, 2 x USB 3, stereo, mic

Drive bays 2 x external 5.25in, 6 x internal 3.5in/2.5in, 2 x internal 2.5in

Form factor(s) Micro-ATX, mini-ITX

Cooling 2 x 120mm front fan mounts (1 x 120mm fan included), 1 x 120mm rear fan mount (fan included), 2 x 140mm or 3 x 120mm roof fan mounts (1 x 140mm fan included), 1 x 120mm lower fan mount

CPU cooler clearance 165mm

Maximum graphics card length 260mm (400mm without hard drive cage)

Phanteks Enthoo Evolv MATX / £100 inc VAT

SUPPLIER www.overclockers.co.uk

The Enthoo Evolv MATX costs £25 more than Corsair and Fractal's offerings this month, but its looks beat both those cases, with an edgy, angular exterior that will stand out at a LAN party. The exterior is devoid of large vents, with just a few small, mesh-covered cut-outs in the roof. However, there are still two 120/140mm fan mounts in the roof, plus a monstrous 200mm fan in the front section, which can alternately play host to a pair of 120mm or 140mm fans.

Phanteks has also used some nifty layout skills to offset the roof's fan mounts away from the motherboard, giving you 68mm of clearance for CPU heatsinks. Full-height 120mm radiators should fit here, although they'll obscure the motherboard. You can also house a double 140mm-fan radiator here, but only half-height models. The fan mounts are open too, so the fans aren't fixed in place – you can move them back and forth along rails.

The front of the case is a little more restrictive, but can still house a double 120mm-fan or single 140mm-fan radiator if you ditch the bottom drive bay. It has a width restriction of 125mm, which is big enough for most 120mm all-in-one liquid coolers, but many third-party radiators won't fit.

The rear of the case also sports a 140mm fan mount with a second fan included, while

the inclusion of a vibration-dampened pump mount bolsters the Phanteks' water-cooling credentials.

Meanwhile, the base of the case is home to the PSU with its own dust filter, and there's a large filter included in the front panel too. You don't have to deal with any screws on the side panels either – they both sit on hinges and pop open, as does the front panel. Build quality is excellent throughout, although the use of steel and thick aluminium in the Evolv's construction means it weighs 9kg – double the weight of the aluminium Cooltek UMX3.

Interestingly, there's a 5.25in bay at the rear, which is useful for a reservoir or fan controller, although you won't want an optical drive at the back. Storage bays are plentiful too – there are five 2.5in bays, although four of them are shared with the three available 3.5in bays. Some bays sit in a removable drive cage at the front, but if you want to remove this cage to fit a radiator, then there's a sideplate that can cater for one 3.5/2.5in drive, plus a 2.5in drive and a third 2.5in mount behind the motherboard tray. Other features include Velcro cable ties, a six-fan hub and numerous cable routing holes around the motherboard.

The Phanteks put in a reasonable if not spectacular performance and was warmer than the likes of Corsair's Obsidian 350D. It



was relatively quiet, but the lack of roof vents and restricted front airflow mean the case is hampered when it comes to cooling.

Conclusion

It's easy to work with the Enthoo Evolv MATX, plus it's well built, good looking and has the best feature set on test. However, it has a comparatively high price, and it could do with some proper roof and front airflow vents. It's otherwise a fantastic case, if a little overpriced.

COOLING 25/30	FEATURES 17/20	OVERALL SCORE 80%
DESIGN 22/30	VALUE 16/20	

VERDICT

Feature-laden, striking and incredibly solid, although the Enthoo Evolv MATX could do with better ventilation.



/ SPECIFICATIONS

Dimensions (mm) 230 x 400 x 450 (W x D x H)

Material Steel, aluminium, plastic

Available colours Black, white

Weight 9kg

Front panel Power, reset, 2 x USB 3, stereo, mic

Drive bays 1 x external 5.25in, 3 x internal 3.5in/2.5in, 2 x internal 2.5in

Form factor(s) Micro-ATX, mini-ITX

Cooling 1 x 200mm or 2 x 140mm/120mm front fan mounts (1 x 200mm fan included), 1 x 140mm/120mm rear fan mount (140mm fan included), 2 x 140mm or 3 x 120mm roof fan mounts (fans not included)

CPU cooler clearance 192mm

Maximum graphics card length 318mm

Raijintek Styx / £75 inc VAT

SUPPLIER www.overclockers.co.uk

As the smallest case in this Labs test, Raijintek's aluminium Styx, which is the larger version of the miniscule Metis, might not seem the best place for all-in-one liquid coolers and water-cooling systems. However, there's a pair of 120mm fan mounts in the roof and the case's extra width means there's space for a pump in the base. As such, the Styx is one of the better micro-ATX cases for liquid cooling, despite its size, and it's also much better suited to housing two air-cooled graphics cards than SilverStone's Kublai KL06 (see p56).

The case is made from aluminium panels, so it's fairly light, and all the panels are screwed, rather than riveted, to the chassis, making it great for stripping down for painting or modding. There's just one 120mm fan included as standard, thankfully installed as an exhaust, plus the aforementioned roof mounts and one more 120mm mount in the base. As the Styx uses an inverted layout, the PSU is also mounted in the front, with a power extension cable running to the rear so you can plug it into the mains as usual.

Drive mounts with rubber grommets are situated in various locations, including the base, and drives can also be mounted on a large, removable beam that stretches across

one side. There are three 3.5in/2.5in bays and two dedicated 2.5in bays, plus the Styx offers an optical drive mount on the side. The latter isn't a full-height 5.25in mount, but it will take a slimline, slot-loading drive.

Installing hardware in the Styx is relatively painless, as there's more room than you might expect. There's 180mm clearance for CPU coolers, which is more than several cases on test, although the 280mm graphics card clearance may block some larger cards. However, there are few places to hide cables, so you'll need plenty of cable ties. One other issue with the Styx is that each side panel is secured using four screws, which makes changing hardware a chore, unlike the Cooltek UMX3's pop-on panels.

The Styx doesn't offer stellar cooling either. Its CPU delta T of 53°C was the highest result on test, as was the identical GPU delta T. We thought that reversing the rear fan and CPU cooler fan might help, but while doing so resulted in a cooler CPU, the GPU became much warmer, so there isn't much room for improvement with the stock configuration. More fans would clearly help, but these results are still far from terrible – being less than 10°C off the best results on test – and the Styx remains very quiet too.



Conclusion

The Styx has plenty of merit for a modding project or liquid-cooled PC, plus its aluminium construction and unusual shape and layout make it refreshingly different. It's a far cry from the comparatively bland Fractal, SilverStone and Corsair cases on test. It's also available in a range of colours and it has an attractively small footprint.

The competition beats the Styx in terms of cooling and features – there are no dust filters of fan controller on the Styx, for example – but it's still worth considering if you're a modder looking for a different case with some flexibility.

COOLING	FEATURES	OVERALL SCORE
23/30	15/20	74%
DESIGN	VALUE	
20/30	16/20	

VERDICT

A great small case for liquid cooling or modding, but the competition beats it in terms of cooling and features.



/SPECIFICATIONS

Dimensions (mm) 210 x 360 x 335 (W x D x H)

Material Aluminium, steel

Available colours Black, silver, blue, gold, red, green

Weight 3.8kg

Front panel Power, 2 x USB 3, stereo, mic

Drive bays 1x slimline 5.25in, 3 x 3.5in/2.5in, 2 x 2.5in

Form factor(s) Micro-ATX, mini-ITX

Cooling 1x 120mm rear fan mount (fan included), 2 x 120mm roof fan mounts, 2 x 120mm side bracket fan mounts (fans not included), 1x bottom 120mm fan mount (fan not included)

CPU cooler clearance 180mm

Maximum graphics card length 280mm

SilverStone Kublai KL06 / £85 inc VAT

SUPPLIER www.scan.co.uk

At just £60, SilverStone's Kublai KL06 is the cheapest micro-ATX case on test this month, and it's one of two cases on test to use an inverted design. The CPU cooler is at the bottom of the case, which can aid cooling, although we're a little disappointed that SilverStone hasn't included a rear fan with the KL06. Two quiet 120mm fans are installed as standard at the front, covered by a mesh and dust filter, but there will be a lot of pressure on the CPU cooler and graphics card to shift warm air out of the case.

One feature we love, though, is the removable motherboard tray – it's a feature you rarely find, but it does make hardware installation much easier. There's also a mass of 2.5in bays – there are eight bays in total and most of them are tool-free and removable. There's also a single 3.5in bay at the bottom and two 5.25in bays too. Interestingly, one of the 2.5in mounts is a plate that you can attach to the side of the PSU cover, which is handy if you just have a single SSD, as you can then remove the 2.5in caddy to improve airflow.

On the downside, you need to remove the roof of the case to install the PSU, which adds a few minutes to the build process. There isn't much space between the motherboard and

PSU, though, which means that the second card in a 2-way graphics setup may struggle for airflow, or simply not fit at all.

There's plenty of room to tuck cables away in the roof, however, and ample space behind the motherboard tray too.

The PSU is housed in the roof with its own dedicated intake, but there are no other vents in the roof or base. The KL06 does offer two 120mm fan mounts for radiators in the front, although fitting a double 120mm-fan radiator here requires you to remove the 3.5in drive mount at the base, and lose a little room in the lower of the two 5.25in bays too.

There's also a single 140mm fan mount in the front that can support 140mm radiators, but not at the same time as either of the 120mm fans.

It turns out our concerns about too much positive air pressure in the KL06 were well founded, as the CPU delta T of 54°C and GPU delta T of 56°C aren't very competitive. Switching the lower of the internal fans to the rear saw the CPU temperature drop by 6°C, but with a slightly warmer GPU temperature. However, moving the fan next to the CPU to the back of the case saw the CPU delta T drop



by 1°C, with the GPU delta T dropping by 5°C. Clearly, the standard fan arrangement isn't optimal, and if you just need one SSD, you can ditch the internal 2.5in drive caddy and lower the CPU temperature by a further 2°C as well.

Conclusion

It's surprising what SilverStone has accomplished for just £60 with the Kublai KL06. It's so inexpensive that we can overlook the average cooling – even if you add a third £5 fan in the rear vent, the KL06 would still undercut the competition, and the extra fan would boost cooling significantly. The KL06 is also easy to use, well made and fairly water cooling friendly, although not ideal for dual-GPU systems.

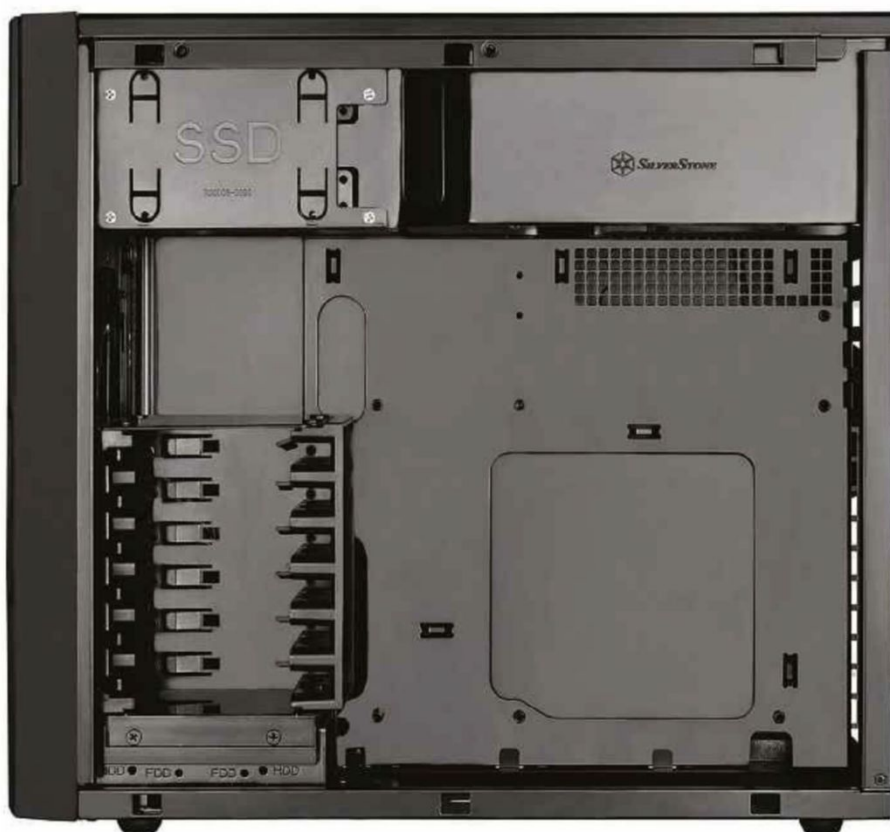
COOLING	FEATURES	OVERALL SCORE
25/30	15/20	83%
DESIGN	VALUE	
24/30	19/20	

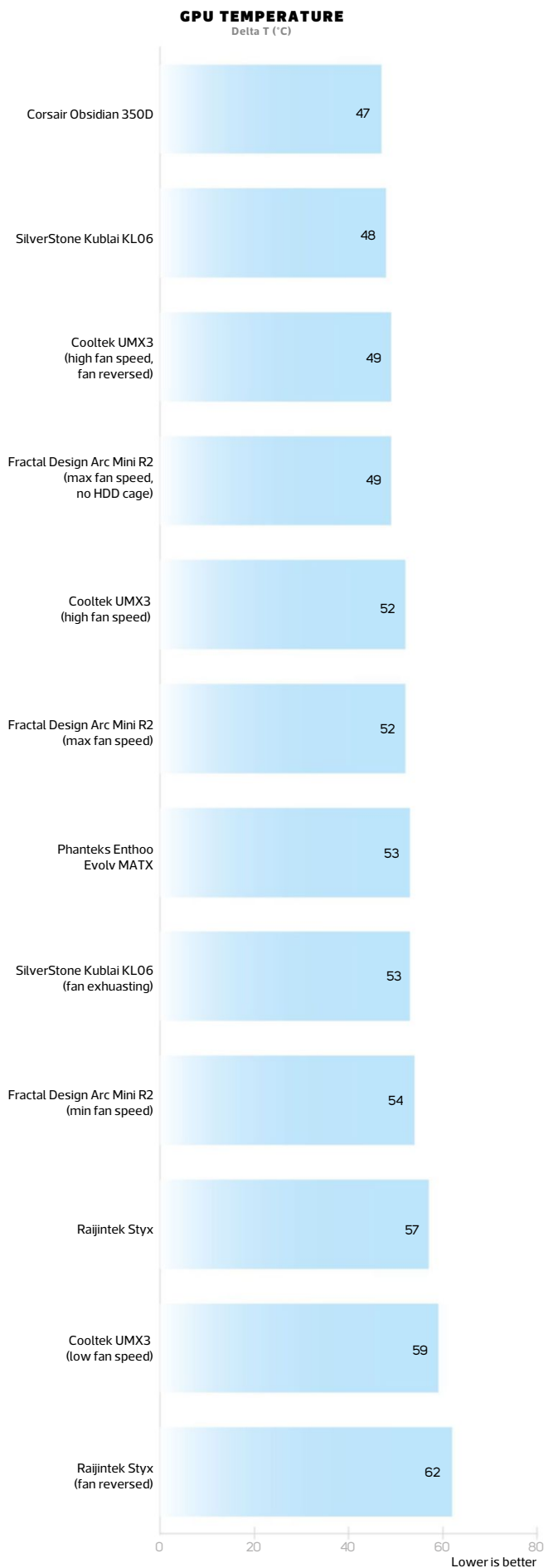
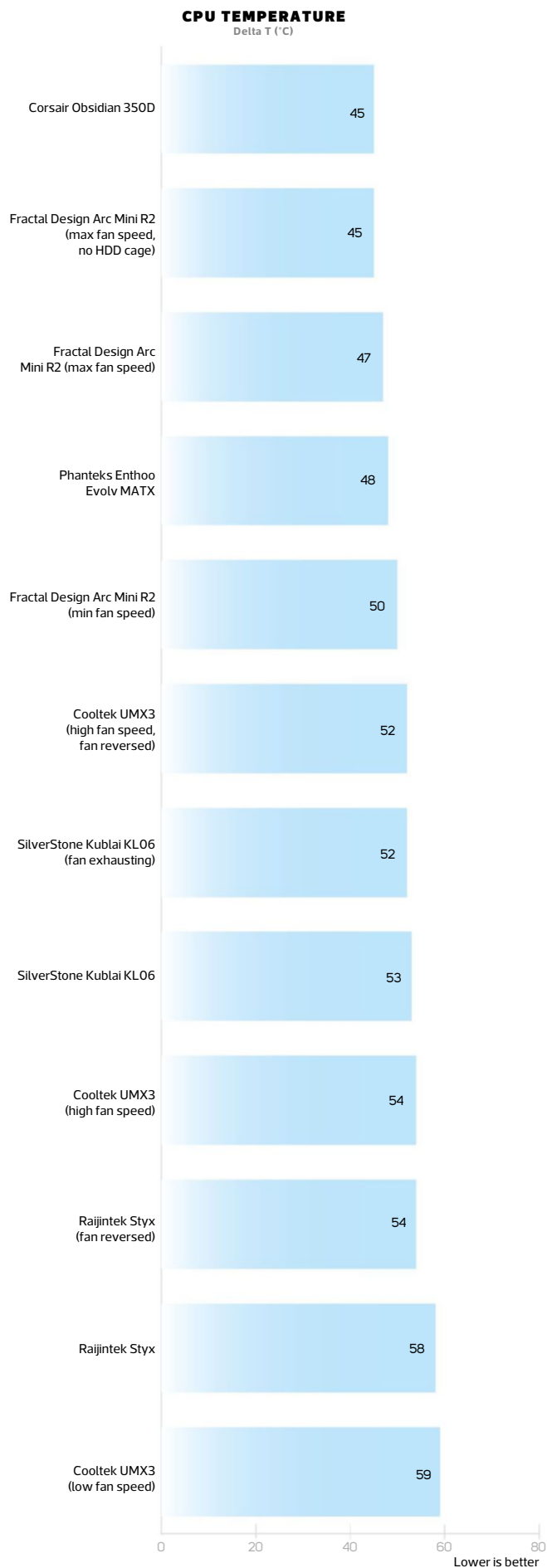
VERDICT

A surprisingly good case for the money. The disappointing out-of-the-box cooling can easily be fixed, and the KL06 is water cooling-friendly too.

/SPECIFICATIONS

Dimensions (mm)	211 x 405 x 375 (W x D x H)
Material	Steel, plastic
Available colours	Black
Weight	5.5kg
Front panel	Power, 2 x USB 3, stereo, mic
Drive bays	2 x external 5.25in, 8 x 2.5in, 1 x 3.5in
Form factor(s)	Micro-ATX, mini-ITX
Cooling	2 x 120mm front fan mounts (fans included), 1 x 120mm rear fan mount (fan not included)
CPU cooler clearance	165mm
Maximum graphics card length	343mm





PC system reviews

GAMING PC

Gladiator Hellcat 1070 / £1,074 inc VAT

SUPPLIER www.gladiatorpc.co.uk

Despite costing a little over a grand, Gladiator's Hellcat 1070 locks and loads Nvidia's new GTX 1070 GPU, with 2,560 stream processors, a 1506MHz core clock that boosts to 1683MHz and 8GB of GDDR5 memory. The last desktop PC we saw in this price bracket was the CyberPower Infinity X55 Pro, which used an AMD Radeon R9 390, a card that's well behind the GTX 1070 in terms of both performance and efficiency.

The rest of the Gladiator's spec is pretty solid for the money too. The Core i5-6600K has been overclocked from 3.5GHz to 4.4GHz – it doesn't support Hyper-Threading, like its Core i7 brother, but it's plenty powerful enough for gaming. It's good to see 16GB of 3000MHz DDR4 memory too. Of course, you have to compromise somewhere when you have a limited budget, so there's no super-fast NVMe storage – instead, you get a basic 250GB Hynix SL301 SSD and a 1TB hard disk.

Meanwhile, Gigabyte's GA-Z170-Gaming K3 ticks most of the boxes we expect from a mid-range gaming motherboard. It offers Killer Ethernet and dedicated audio circuitry, along with an M.2 connector and USB 3.1 Type-A ports. That said, there's little about this board that stands out. The most outlandish feature is the lighting strip, which sits along the right side of the PCB and emits a red glow.

The light ties in with the board's red and black theme, which the PC matches. The single 120mm case fan is illuminated with a red LED, the G.Skill memory is red and black, and there's a strip of white LEDs in the roof for contrast. The Aerocool Aero-800 chassis itself is all black, with a window showing the insides. It's a tall, narrow, no-nonsense case. There's plenty of room to work inside it, and the interior is tidy thanks to careful cable routing and a shroud over the Corsair PSU.

That said, the PSU shroud looks dull and boxy, and it's made from flimsy metal. The side panels are a little weak too, the front façade is an underwhelming slab of mesh and plastic, and there's no cosmetic flair anywhere else. The case offers room to add

several SSDs, but it's trickier to add a hard disk – there's only one free bay, and it's already filled with spare cables. Those cables come from the Corsair VS650 PSU, which has captive cables, and only has the basic 80 Plus White certification. It does the job, but it's at the basic end of the scale.

Likewise, while it's good to see liquid cooling in this system, the Corsair Hydro H45 CPU cooler is at the bottom end of the scale. Gladiator has added another fan to the H45 to help keep the overclocked CPU in check, but it ends up being noisy as a result. Gladiator's PC is protected by its standard four-year labour warranty, with two months of

collect and return cover. That's a generous length of deal, but the all-important parts coverage only lasts for a year.

Performance

Thanks to the GeForce GTX 1070 card, the Hellcat 1070 stormed through our 1080p gaming tests, never dropping below 70fps in even the toughest tests. It didn't balk at running games at 2,560 x 1,440, either, with minimums of 46fps in Crysis 3, 48fps and in Fallout 4, and a superb 63fps in The Witcher 3: Wild Hunt. There's a huge gulf between the Gladiator and CyberPower's rival from just a few months ago. The CyberPower could only manage a 32fps minimum in Crysis 3 at 2,560 x 1,440. The impressive performance doesn't just mean good 2,560 x 1,440 gaming either – this PC has the power for VR too.

The Gladiator couldn't quite cope with the heavy demands of 4K gaming though. Its minimum of 35fps in The Witcher 3 is good, but it dropped below 25fps in our other two test games. You could probably make Fallout 4 playable by dropping to High settings, but if you really want 4K gaming, you need to spend more money on your PC.

Meanwhile, the overclocked Core i5 is an able companion for Nvidia's new GPU. Its overall score of 119,123 shows it has the power for most people's software needs. It might not have the multi-threaded abilities of Core i7 chips, but it's more than powerful enough for gaming.

The SSD is nothing special though. Its sequential read and write speeds of 523MB/sec and 455MB/sec respectively aren't bad for a SATA SSD, but an NVMe drive will be much quicker. That said, it's good to have 250GB of solid state storage for Windows and games.

/SPECIFICATIONS

CPU 3.5GHz Intel Core i5-6600K overclocked to 4.4GHz

Motherboard Gigabyte Z170-Gaming K3

Memory 16GB Corsair Vengeance LPX 3000MHz DDR4

Graphics Zotac GeForce GTX 1070 8GB

Storage 250GB Hynix SL301 SSD; 1TB Toshiba hard disk

Case Aerocool Aero-800

Cooling CPU: Corsair Hydro H45 with 2 x 120mm fan; GPU: 1 x 70mm fan; front: 1 x 120mm fan

PSU Corsair VS650 650W

Ports Front: 2 x USB 3, 2 x USB 2, 2 x audio; rear: 4 x USB 3, 2 x USB 3.1 Type-A, 1 x PS/2, 1 x Gigabit Ethernet, 6 x audio

Operating system Microsoft Windows 10 Home 64-bit

Warranty One year parts and labour, with two months collect and return, then return to base, followed by three years labour only return to base



- 1 It's great to see a GeForce GTX 1070 in a system costing just over a grand
- 2 The Core i5-6600K processor has been overclocked to 4.4GHz
- 3 The two fans on the Corsair H45 help to keep the CPU cool, but they're noisy

The Gladiator's main issue, though, is its noise output. Its fans took a long while to quiet down and stop modulating when the PC was first booted, and its idle noise output was noticeably loud – certainly louder than most other gaming rigs when they're not running any applications. The noise became louder during stress tests too, going beyond the levels we hear from most gaming systems. On the plus side, the CPU and GPU delta Ts of 42°C and 58°C are fine.

Conclusion

The GTX 1070 is an exceptional card for gaming at 1080p and 2,560 x 1,440, and even at 4K if you don't mind dropping the settings a little, and it's good for VR headsets too. The rest of the Gladiator's core specification is fine too, from the overclocked processor to the ample memory.

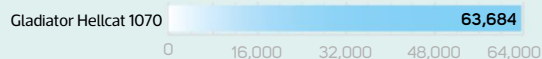
The GTX 1070 is an expensive card, though, and that means making compromises in other areas, most notably with the case, SSD, PSU and cooling in this PC. Gladiator has done its best in terms of cable routing, and the Hellcat 1070 is a well built PC. The main issue, though, is noise. At this price,



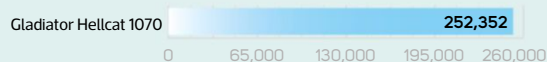
you can't help feeling that a large air cooler would have been a better choice than a cheap liquid cooler. If noise isn't an issue to you, though, and you want the best gaming performance possible for around a grand, the Hellcat 1070 delivers the goods.

MIKE JENNINGS

CPC REALBENCH 2015 GIMP IMAGE EDITING



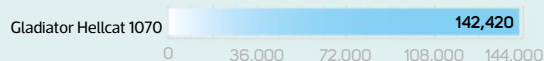
HANDBRAKE H.264 VIDEO ENCODING



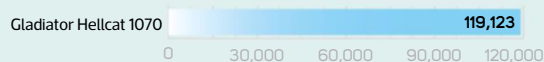
LUXMARK OPENCL



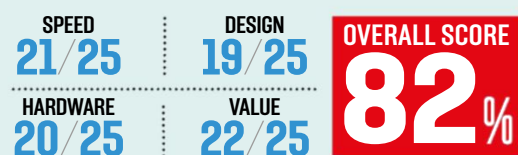
HEAVY MULTITASKING



SYSTEM SCORE



INTEL REFERENCE: 104.08%

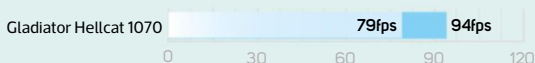


VERDICT

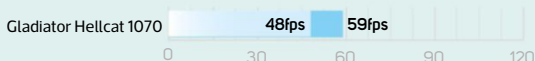
Fantastic performance for the money, and a tidy build, but the Hellcat 1070 is very noisy.

FALLOUT 4

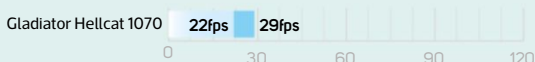
1,920 x 1,080, Ultra Detail, TAA



2,560 x 1,440, Ultra Detail, TAA



3,840 x 2,160, Ultra Detail, TAA



THE WITCHER 3: WILD HUNT

1,920 x 1,080, High Detail, AA on



2,560 x 1,440, High Detail, AA on

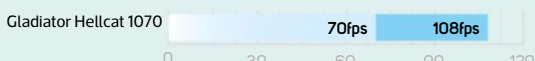


3,840 x 2,160, High Detail, AA on

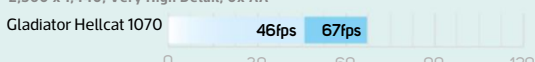


CRYSIS 3

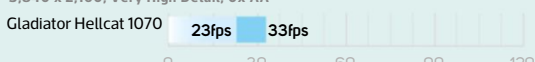
1,920 x 1,080, Very High Detail, 0x AA



2,560 x 1,440, Very High Detail, 0x AA



3,840 x 2,160, Very High Detail, 0x AA



Minimum Average

GAMING PC

Overclockers Kinetic H3 / £761 inc VAT

SUPPLIER www.overclockers.co.uk

We don't normally see systems costing less than £800 in **Custom PC**, but the Overclockers Kinetic H3 goes beyond the usual low-budget spec by offering a Radeon RX480 card. The RX480 sees AMD taking a different approach to Nvidia. Instead of launching with a flurry at the top of the stack, the new Radeon is a mid-range card that promises to deliver 1080p and 2,560 x 1,440 gaming for a reasonable price.

The RX480 marks the debut of the fourth iteration of AMD's Graphics Core Next architecture. It's the first time AMD has shrunk its GPUs' manufacturing process to a tiny 14nm, enabling AMD to cram loads of transistors into the small chip. The RX480 includes 2,304 stream processors, and the card in the Kinetic H3 comes with 8GB of RAM too. The RX 480 is undoubtedly this machine's key component, though, and the rest of the specification reflects the Kinetic's affordable status.

The Core i5-6400 CPU, for example, is a mid-tier quad-core Skylake processor without Hyper-Threading, and its stock speed of 2.7GHz can rise to 3.3GHz with Turbo Boost. It will be fine for gaming, but it doesn't have an unlocked multiplier, so you won't be able to overclock it. As such, high-end CPU cooling isn't needed, so Overclockers has used a standard Intel stock heatsink. On the plus side, you at least get a 240GB solid state drive, along with a 1TB hard disk. There's 8GB of 2400MHz DDR4 memory too, which isn't spectacular but is more than up to the job of gaming needs.

The bland Asus H110-Plus motherboard is limited, too. Based on Intel's entry-level H110 chipset, it has spare PCI and 1x PCI-E 2 slots for future upgrades, but there's no scope for

adding a second GPU, there's no M.2 connector for adding a fast NVMe SSD and there are no empty memory slots either. There are only two memory slots, and they're already occupied – if you want to upgrade to 16GB of RAM later, you'll need to replace all the memory.

Despite these limitations, though, the Kinetic's specification is absolutely fine for everyday use: it won't bottleneck the GPU in games and it has ample power for work and web browsing. The main limitations are future upgrades and tweaking.

Meanwhile, the Kolink Refractor case is a fine, functional mid-sized tower. Its front panel is glossy and without decoration, and its comprehensive front I/O panel is positioned at the top of the case.

Build quality is merely middling though – the plastic used throughout the chassis has a little give if it's put under pressure, and the metal side panels rattle a bit.

It's function over form on the inside, too. The 80Plus Bronze-certified Kolink KL-500 PSU isn't modular and its cables aren't shrouded



with black netting, so they're easily visible as they trail throughout the case. Overclockers has tied down the cables neatly, but they're still clearly visible. It isn't the best-looking system inside, but its modest blue LEDs and tinted side window add a touch of class from the outside.

Finally, the three year warranty includes a year of labour coverage, and two years of collect and return parts and labour cover. That's a decent deal for the money – it's the same standard warranty that Overclockers includes with machines that cost three or four times this price.

Performance

Despite the Kinetic H3's low price, the AMD RX480 card enabled it to produce some surprisingly quick gaming frame rates. It returned a minimum of at least 45fps in every test at 1080p, with averages then heading north of 60fps in two of our test games, so games will run smoothly, with hardly any visible judders or slowdown.

The Kinetic's poorest minimum at 2,560 x 1,440 came in Crysis 3, where it could only manage 28fps. That's barely above the 25fps target where we consider a game to be borderline playable, but it will only take a little tweaking in the settings to get it up to 30fps. The H3 was better in other games at this resolution, maintaining 30fps in Fallout 4 and never dropping below 40fps in The Witcher 3: Wild Hunt.

Not surprisingly, though, the stock speed Core i5 CPU could only deliver comparatively mediocre benchmark results. Its image editing result of 41,330 really shows the CPU's lack of clock speed compared with overclocked chips, and its overall score of 87,115 isn't spectacular, with a reference score of 76.11 per cent compared to our Devil's Canyon Core i7 test bench.

That score is hardly going to break records, but the CPU is still plenty quick enough for general computing tasks, and it has just enough power to support the GPU in games at sub-4K resolutions.

/SPECIFICATIONS

CPU 2.7GHz Intel Core i5-6400

Motherboard Asus H110-Plus

Memory 8GB Team Group Elite 2400MHz DDR4

Graphics Sapphire Radeon RX480 8GB

Storage Kingston 240GB SSDNow V300 SSD; 1TB hard disk

Case Kolink Refractor

Cooling CPU: Intel stock cooler with 1x 80mm fan; GPU: 1x 70mm fan; front: 2x 120mm fans; rear: 1x 120mm fan

PSU Kolink KL-500 500W

Ports Front: 2x USB 3, 2x USB 2, 2x audio; rear: 2x USB 3, 2x USB 2, 2x PS/1, 1x Gigabit Ethernet, 3x audio

Operating system Microsoft Windows 10 Home 64-bit

Warranty Two years parts and labour collect and return, followed by one year labour only return to base

- 1** The AMD Radeon RX480 graphics card is the star of the show
- 2** A simple Intel stock cooler sits on top of the non K-series Core i5 CPU
- 3** The PSU cables aren't pretty, but at least they're routed out of the way

Meanwhile, the Kingston SSD rattled through our read and write tests at 493MB/sec and 456MB/sec respectively. That's a tad behind the best SATA drives and further behind M.2 hardware, but it's a good set of results for a budget drive. It's great to have 240GB of solid state storage for Windows and games on a budget system anyway.

We had no trouble during thermal tests either. The CPU and GPU delta Ts of 35°C and 58°C are entirely normal, and the Kinetic was virtually inaudible when running low-end tasks. It wasn't much louder during gameplay – even in a quiet room the fan noise will be subtle.

Conclusion

The AMD RX480 is the undoubted star component in this system, and it's a great addition to this affordable gaming rig. It blitzed our test titles at 1080p and handled most of them fine at 2,560 x 1,440 too. Few systems have delivered this much gaming power for less than £800.

With more than a quarter of its budget devoted to the GPU, the Kinetic is understandably more ordinary elsewhere – but crucially, it's never bad. The only problem is the lack of upgrade room from the budget motherboard.

Otherwise, the Core i5 CPU is capable, there's an SSD and enough DDR4 memory, the fan noise isn't awful and the case is kept reasonably tidy. The Kinetic H3 doesn't have the



sheen of pricier machines, but we don't expect that for this price. Instead, this PC delivers great gaming abilities and competence elsewhere, and that's the best you can ask if you want an affordable gaming rig.

MIKE JENNINGS

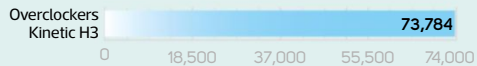
CPC REALBENCH 2015 GIMP IMAGE EDITING



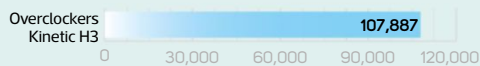
HANDBRAKE H.264 VIDEO ENCODING



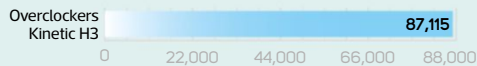
LUXMARK OPENCL



HEAVY MULTITASKING



SYSTEM SCORE



INTEL REFERENCE: 76.11%

SPEED
18/25

HARDWARE
18/25

DESIGN
18/25

VALUE
24/25

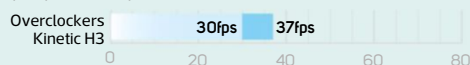
OVERALL SCORE
78%

FALLOUT 4

1,920 x 1,080, Ultra Detail, TAA

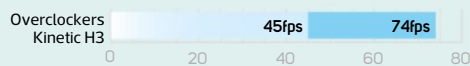


2,560 x 1,440, Ultra Detail, TAA



THE WITCHER 3: WILD HUNT

1,920 x 1,080, High Detail, AA on

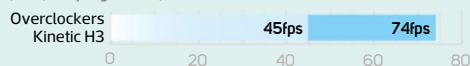


3,840 x 2,160, Very High Detail, FXAA

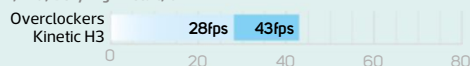


CRYSIS 3

1,920 x 1,080, Very High Detail, 0x AA



2,560 x 1,440, Very High Detail, 0x AA



Minimum Average

VERDICT

Fantastic frame rates for the money, low-noise operation and a tidy build, although this sub-£800 PC understandably compromises in other areas, especially upgrade room.

GAMING PC

Scan 3XS Z170 Nanu Vengeance Fluid / £2,400 inc VAT

SUPPLIER www.scan.co.uk

Nvidia's new Pascal architecture has delivered incredible performance gains, meaning you can realistically play many games at 4K with decent settings without a dual-GPU setup. It means the GeForce GTX 1080 is ideal for a mini-ITX rig such as Scan's 3XS Z170 Nanu Vengeance Fluid, where the form factor limits you to a single 16x PCI-E slot. Not only that, but Scan has also squeezed a full water-cooling loop into this system's NZXT Manta case, chilling both the GTX 1080 and the Core i7-6700 CPU.

The water-cooling hardware is impressively compact; a 240mm EK-CoolStream PE radiator occupies the front of the case, and the short EK-X3 150mm cylindrical reservoir sits in the middle, with black rubber tubing flowing between the components. Meanwhile, the Alphacool D5 pump is hidden around the back, behind the shroud that covers the Corsair PSU.

It looks excellent, not least because Scan has carefully hidden the cables and chosen a monochrome theme. The white Mayhems coolant and roof-mounted white LEDs stand out amid the darkness elsewhere, and Scan has sensibly used a black Manta to provide contrast.

The Manta looks good on the outside too. Its gentle curves stand apart from boxier rivals, and its matt finish is attractive too. There's no decoration, save for a subtle white line on the top, and the bulging side panels are designed to give more room for cables and components – the 2TB hard disk is installed around the back and simply wouldn't fit against a flat side panel. It's a little big for a mini-ITX case, but that's the price you pay if you need more room inside. Build quality is also excellent. You'll be able to carry this rig to and from LAN events without worrying about it falling apart, although it's heavy considering its small stature.

There's only one downside to this particular machine, which is a near-total lack of upgrade room. The motherboard is impossible to reach without basically dismantling the system, and there's no room for more storage. On the plus side, this PC is clearly designed to last without upgrades for a good while. The 16GB of 3000MHz DDR4 memory is plenty for gaming and most people's work needs, and Windows 10 Home is installed on a fast 256GB Samsung 950 Pro SSD.

Scan has tweaked Nvidia's new hardware too. The EVGA card's 1607MHz core frequency has been increased to 1732MHz, although the memory has only been given a 10MHz boost. Likewise, the 4GHz Core i7-6700K has been overclocked to 4.6GHz – we don't see many full-sized systems go beyond that clock speed, let alone a rig this small.



Meanwhile, the Asus Z170i Pro Gaming is a powerhouse mini-ITX motherboard, featuring dual-band 802.11ac Wi-Fi and SupremeFX audio, along with the crucial M.2 socket that's lacking on Asus' current Impact board. Its backplate is well stocked too, with four USB 3 ports, a pair of USB 3.1 Type-A ports and five audio jacks.

Finally, there's the PSU. The Corsair CX550M is reasonable rather than outstanding: it's only semi-modular, and it has a decent 80 Plus Bronze certification.

The machine also benefits from Scan's great warranty, which offers a great deal that includes parts coverage a full three years, with the first year on site.

Performance

There's an incredible amount of gaming performance inside this small system. It sailed through all our game tests at 1080p and 2,560 x 1,440 – its lowest result at these two resolutions was a still very smooth 57fps minimum. There's little to worry about at 4K either. It managed 30fps and 38fps minimums in Crysis 3 and The Witcher 3, and only fell below 30fps in Fallout 4 – dropping this game from Ultra to Very High settings will easily make it smoothly playable.

Application performance is solid too. The Scan's overclocked Core i7 chip delivered an overall score of 147,947, which would have secured a mid-table slot in last month's Labs test of full-sized ATX PCs.

The rapid performance is also bolstered by the SSD's class-leading read and write speeds of 1,938MB/sec and 1,279MB/sec respectively.

Of course, the tight confines of this machine meant we paid close attention to thermal tests. The water-cooling loop undoubtedly helps, as does Nvidia's new thermally efficient Pascal architecture, with a peak GPU delta T of just 33°C. However, the CPU delta T peaked at 69°C – a top real-world temperature of 92°C in this hot summer. It's within thermal

/SPECIFICATIONS

CPU 4Hz Intel Core i7-6700K
overclocked to 4.6GHz

Motherboard Asus Z170i
Pro Gaming

Memory 16GB Corsair
Vengeance LPX 3000MHz
DDR4

Graphics EVGA GeForce GTX
1080 8GB

Storage 256GB Samsung 950
Pro M.2 SSD; 2TB Western
Digital Blue hard disk

Case NZXT Manta

Cooling CPU: EK-Supremacy
EVO waterblock,
EK-CoolStream PE 240
radiator, EK-X3 150 reservoir,
Alphacool D5 PWM pump;
GPU: EK-FC1080 waterblock;
rear: 1x 120mm fan

PSU Corsair CX550M 550W

Ports Front: 2 x USB 3, 2 x
audio; rear: 4 x USB 3, 2 x USB
3.1 Type-A, 2 x USB 2, 1 x PS/2,
1 x Gigabit Ethernet, 1 x optical
S/PDIF, 5 x audio

Operating system Microsoft
Windows 10 Home 64-bit

Warranty Three years parts
and labour, with first year
onsite, and second and third
years return to base



1
An EK-X3 150mm cylindrical reservoir sits in the middle



2
The water-cooling loop keeps the GTX 1080 very cool

3
The Core i7-6700K runs at 4.6GHz, although it gets hot

limits, but it's also undoubtedly very hot, and it also caused the CPU to throttle back to 4GHz. Most people won't stress their CPU at full load for long periods of time in the real world, but it shows that Scan's CPU overclock is a little ambitious.

Noise wasn't too bad though. The Scan produces a modest whirr when it isn't being pushed and more of a fan noise when stress-tested – but it's no worse than the average full-sized gaming system.

Conclusion

Despite its size, the 3XS Z170 Nanu Vengeance Fluid has the power to handle 4K gaming and, thanks to Nvidia's Pascal architecture and a water-cooling loop, the GPU is perfectly cool. The build is great too, with a tidy interior and great looks. The rest of the spec is solid, from the overclocked CPU to the motherboard and storage. Our only criticisms are that the

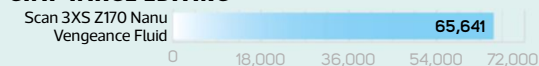


CPU overclock is a notch too high for this system, and there isn't much upgrade room, but if you want a small, good-looking, well-built and fast PC, this is a superb example. We'd just ask Scan to tone down the overclock a little for you.

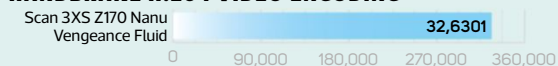
MIKE JENNINGS

CPC REALBENCH 2015

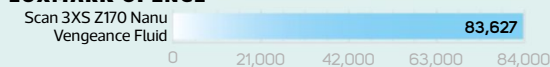
GIMP IMAGE EDITING



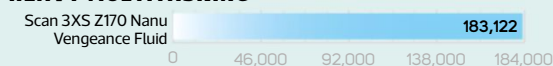
HANDBRAKE H.264 VIDEO ENCODING



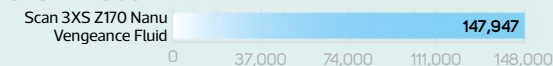
LUXMARK OPENCL



HEAVY MULTITASKING



SYSTEM SCORE



INTEL REFERENCE: 129.26%

SPEED
23/25

HARDWARE
24/25

DESIGN
23/25

VALUE
20/25

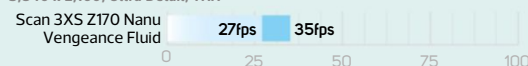
OVERALL SCORE
90%

FALLOUT 4

2,560 x 1,440, Ultra Detail, TAA

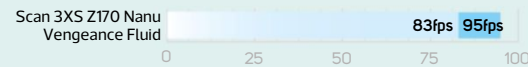


3,840 x 2,160, Ultra Detail, TAA

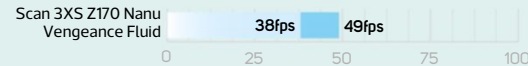


THE WITCHER 3: WILD HUNT

2,560 x 1,440, High Detail, AA on

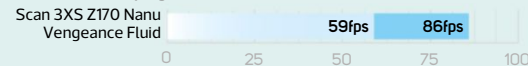


3,840 x 2,160, High Detail, AA on

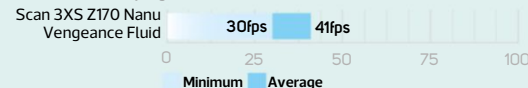


CRYSIS 3

2,560 x 1,440, Very High Detail, 0x AA



3,840 x 2,160, Very High Detail, 0x AA



VERDICT

A sturdy mini-ITX PC with a huge amount of power, smart looks and custom water cooling, although the CPU gets hot.

Elite

Our choice of the best hardware available

Build a home theatre PC

The parts you'll need to build an affordable, home theatre PC that's ideal for putting in the lounge and playing back all manner of video formats. This machine will handle general computing and media tasks with no trouble, and its dual-core Skylake CPU can even handle 4K video playback. Meanwhile, its super-quiet Noctua CPU cooler prevents it from making a racket.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Lian Li PC-Q09FNB with 300W FSP SFX PSU	www.overclockers.co.uk	Issue 149, p92	£125
	Intel Core i3-6100T	www.overclockers.co.uk	Issue 149, p92	£102
	Asus H110i-Plus D3	www.scan.co.uk	Issue 149, p92	£60
	8GB Corsair 2133MHz Vengeance LP DDR3 (CML8GX3M2A2133C11B)	www.scan.co.uk	Issue 149, p92	£45
	Noctua L9i	www.scan.co.uk	Issue 149, p93	£32
	Samsung SN-208FB	www.overclockers.co.uk	Issue 149, p93	£17
	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£61
	Samsung 850 Evo 250GB	www.scan.co.uk	Issue 141, p51	£81
	Logitech K400 Plus	www.scan.co.uk	Issue 149, p93	£30
	Microsoft Windows 10 Home Retail USB drive	www.scan.co.uk	Issue 146, p17	£90
TOTAL				£643

Build a budget gaming PC

The parts you'll need to build a budget machine capable of playing the latest games at maximum settings on a 1080p monitor, and even some games at 2,560 x 1,440. The machine has a discrete graphics card, a Skylake dual-core CPU and DDR4 memory. The ASRock Extreme4 motherboard is also capable of base clock overclocking via a BIOS update.










	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	NZXT S340	www.overclockers.co.uk	Issue 137, p54	£65
	ASRock Z170 Extreme4	www.scan.co.uk	Issue 151, p84	£113
	Intel Core i3-6100	www.scan.co.uk	Issue 151, p18	£100
	8GB (2 x 4GB) Corsair Vengeance LPX 2400MHz (CMK8GX4M2A2400C16)	www.scan.co.uk	Issue 151, p83	£41
	Asus Radeon R9 380 Strix 2GB	www.box.co.uk	Issue 150, p48	£155
	Samsung 850 Evo 250GB	www.scan.co.uk	Issue 141, p51	£81
	SilverStone Argon AR01	www.scan.co.uk	Issue 132, p57	£26
	EVGA SuperNova GS 550W	www.cclonline.com	Issue 146, p50	£73
	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£61
	Microsoft Windows 10 Home Retail USB drive	www.scan.co.uk	Issue 146, p17	£90
			TOTAL	£805



Build a mid-range PC

Work PC

The parts you'll need to build a solid quad-core PC with plenty of upgrade potential. This kit list gives you an all-in-one liquid cooler and a K-series Core i5 Skylake CPU, meaning you can overclock it and get some serious processing power. We've managed to get the Core i5-6600K Skylake CPU up to 4.6GHz, so it has some great performance potential. Also included is a solid EVGA PSU, a fast M.2 SSD and 8GB of high-speed DDR4 memory. The core configuration assumes you won't be doing any serious gaming, however, and it relies on Intel's integrated graphics.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	SilverStone Primera PM01 UPDATED	www.scan.co.uk	Issue 157, p25	£90
	Asus Maximus VIII Ranger	www.scan.co.uk	Issue 147, p44	£160
	Intel Core i5-6600K	www.scan.co.uk	Issue 145, p17	£213
	8GB Corsair Vengeance LPX 2666MHz DDR4 (CMK8GX4M2A2666C16)	www.scan.co.uk	Issue 145, p24	£44
	NZXT Kraken X41	www.overclockers.co.uk	Issue 138, p57	£83
	EVGA SuperNova GS 550W	www.cclonline.com	Issue 146, p50	£73
	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£61
	Samsung SSD 950 Pro 256GB	www.ebuyer.com	Issue 149, p48	£145
	Microsoft Windows 10 Home Retail USB drive	www.scan.co.uk	Issue 146, p17	£90
			TOTAL	£959

Gaming PC










The graphics card you'll need to play current games at their maximum settings at 1080p and 2,560 x 1,440.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	1,920 x 1,080 Asus Radeon R9 380 Strix 2GB	www.box.co.uk	Issue 150, p48	£155
	2,560 x 1,440 Nvidia GeForce GTX 1060 6GB UPDATED	www.scan.co.uk	Issue 157, p20	£230

Build a performance PC

Work PC

The parts you'll need to build a high-quality, fast PC that's ideal for multi-threaded workloads. This kit list features a high-quality, well-built case, a feature-rich motherboard and an Intel Skylake Core i7-6700K CPU. This processor's support for Hyper-Threading splits the resources of the CPU's four physical cores into a further four virtual cores, meaning it can effectively handle eight threads at once. There's also a solid Corsair 750W PSU, giving you plenty of headroom for overclocking and adding another GPU, 16GB of DDR4 memory, a high-speed M.2 SSD and a proper liquid-cooling system.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Cooler Master Cosmos SE	www.scan.co.uk	Issue 144, p41	£100
	Asus Maximus VIII Hero	www.overclockers.co.uk	Issue 146, p20	£188
	Intel Core i7-6700K	www.scan.co.uk	Issue 145, p17	£309
	16GB Corsair Vengeance LPX 2666MHz DDR4 (CMK16GX4M2A2666C16)	www.scan.co.uk	Issue 145, p24	£79
	Alphacool Eisbaer 240 UPDATED	www.aquatuning.co.uk	Issue 157, p28	£99
	Corsair RM750i	www.scan.co.uk	Issue 146, p55	£120
	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£61
	Samsung SSD 950 Pro 512GB	www.ebuyer.com	Issue 149, p48	£250
	Microsoft Windows 10 Home Retail USB drive	www.scan.co.uk	Issue 146, p17	£90
			TOTAL	£1,296

Gaming PC

The graphics card you'll need to play current games at their maximum settings at 2,560 x 1,440 and beyond.












	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	2,560 x 1,440 Nvidia GeForce GTX 1060 6GB UPDATED	www.scan.co.uk	Issue 157, p20	£230
	4K Asus Strix GeForce GTX 1070 OC	www.scan.co.uk	Issue 156, p24	£500



Build a high-end 6-core PC


Multi-threaded PC

The parts you'll need to build a PC with serious power in multi-threaded software, such as 3D rendering apps, video editing programs and optimised distributed computing software. The kit list features a 6-core LGA2011-v3 CPU, which is overclockable using the motherboard and top-end cooler listed. Also supplied is 16GB of RAM, a super-fast M.2 SSD, 1TB of extra solid state storage and Asus' superb X99 Deluxe II motherboard.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Phanteks Enthoo Luxe	www.eclipsecomputers.com	Issue 144, p53	£138
	Asus X99 Deluxe II	www.scan.co.uk	Issue 156, p43	£375
	Intel Core i7-6850K	www.overclockers.co.uk	Issue 156, p26	£550
	Asus Radeon R9 380 Strix 2GB	www.box.co.uk	Issue 150, p48	£155
	16GB Corsair Vengeance LPX 2666MHz DDR4 (CMK16GX4M4A2666C16)	www.scan.co.uk	Issue 136, p14	£88
	EKWB EK-Predator 240 Rev 1.1	www.scan.co.uk	Issue 148, p30	£180
	Corsair RM750i	www.scan.co.uk	Issue 146, p55	£120
	Samsung SSD 950 Pro 512GB	www.ebuyer.com	Issue 149, p48	£250
	Samsung 850 Evo 1TB	www.cclonline.com	Issue 141, p51	£263
	Lite-On IHAS124-14	www.shop.bt.com	Issue 99, p108	£10
	Microsoft Windows 10 Home Retail USB drive	www.scan.co.uk	Issue 146, p17	£90
			TOTAL	£2,219

4K gaming PC








Replace the Asus Radeon R9 380 Strix 2GB with a single GeForce GTX 1070 graphics card to enable basic 4K gaming on this system, or take advantage of the Core i7-6850K's 40 PCI-E 3 lanes and add two GPUs.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	4K Asus Strix GeForce GTX 1070 OC	www.scan.co.uk	Issue 156, p24	£500
			TOTAL	£2,564

Build a mini PC

Core components

The parts you'll need to build either PC. This kit list gives you a solid PSU, 16GB of RAM, an overclockable Skylake CPU, an all-in-one liquid cooler and Windows 10 Home 64-bit. Also included is a graphics card that can play current games at their maximum settings at 2,560 x 1,440, and a high-speed M.2 SSD.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Intel Core i7-6700K	www.scan.co.uk	Issue 147, p84	£309
	16GB (2 x 8GB) Corsair Vengeance LPX 2666MHz	www.scan.co.uk	Issue 147, p84	£79
	Corsair H80i	www.scan.co.uk	Issue 147, p84	£80
	Nvidia GeForce GTX 1060 6GB	www.scan.co.uk	Issue 157, p20	£230
	Samsung SSD 950 Pro 512GB	www.ebuyer.com	Issue 149, p48	£250
	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£61
	EVGA SuperNova GS 550W	www.cclonline.com	Issue 146, p50	£73
	Microsoft Windows 10 Home Retail USB drive	www.scan.co.uk	Issue 146, p17	£90



Mini-ITX PC

The parts you'll need to build a pint-sized powerhouse.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Fractal Design Define Nano S	www.scan.co.uk	Issue 153, p22	£60
	Asus Z170i Pro Gaming	www.scan.co.uk	Issue 147, p26	£133
			TOTAL	£1,365










Micro-ATX PC

The parts you'll need to build a mini PC that doesn't take up as much room as a full-sized desktop.





	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Fractal Design Arc Mini R2	www.cclonline.com	Issue 157, p53	£74
	Asus Maximus VIII Gene	www.overclockers.co.uk	Issue 147, p42	£185
			TOTAL	£1,431





Cases

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Budget ATX	NZXT S340	www.overclockers.co.uk	Issue 137, p54	£53
	Sub-£100 performance	SilverStone Primera PM01 UPDATED	www.scan.co.uk	Issue 157, p24	£65
	Sub-£100 ATX quiet	Fractal Design Define R5	www.scan.co.uk	Issue 137, p20	£85
	Sub-£150 full-sized ATX quiet	Nanoxia Deep Silence 5	www.quietpc.com	Issue 144, p50	£126
	Sub-£150 full-sized ATX	Phanteks Enthoo Luxe	www.eclipsecomputers.com	Issue 144, p53	£138
	Sub-£150 mid-size ATX	Cooler Master Cosmos SE	www.scan.co.uk	Issue 144, p41	£100
	Mini-ITX tower	Fractal Design Define Nano S	www.scan.co.uk	Issue 153, p22	£60
	Mini-ITX cube	Fractal Design Core 500	www.scan.co.uk	Issue 150, p20	£53
	Micro-ATX	Fractal Design Arc Mini R2	www.cclonline.com	Issue 157, p53	£74



Graphics cards

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	1,920 x 1,080 gaming	Asus Radeon R9 380 Strix 2GB	www.box.co.uk	Issue 150, p48	£155
	2,560 x 1,440 gaming	Nvidia GeForce GTX 1060 6GB UPDATED	www.scan.co.uk	Issue 157, p20	£230
	4K gaming	Asus Strix GeForce GTX 1070 OC	www.scan.co.uk	Issue 156, p24	£500
	Mini-ITX	Asus GeForce GTX 970 DirectCU Mini	www.cclonline.com	Issue 150, p38	£274






Power supplies

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Mid-range 550W	EVGA SuperNova GS 550W	www.cclonline.com	Issue 146, p50	£73
	High-end 550W	Super Flower Leadex Platinum 550W	www.overclockers.co.uk	Issue 146, p52	£95
	Mid-range 750W	Corsair RM750i	www.scan.co.uk	Issue 146, p55	£120
	High-end 1.2kW	Corsair Professional Series AX1200i	www.scan.co.uk	Issue 111, p40	£250







Networking

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Router	Asus RT-AC68U	www.cclonline.com	Issue 128, p88	£149
	Wi-Fi adaptor	Asus PCE-AC68	www.cclonline.com	Issue 128, p88	£70








Storage

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Hard disk	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£61
	250GB SATA SSD	Samsung 850 Evo 250GB	www.scan.co.uk	Issue 141, p51	£81
	1TB SATA SSD	Samsung 850 Evo 1TB	www.cclonline.com	Issue 141, p51	£263
	High-performance M.2 SSD	Samsung SSD 950 Pro 512GB	www.ebuyer.com	Issue 149, p48	£250
	NAS box	Synology DS216j	www.scan.co.uk	Issue 154, p28	£132

Monitors

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	24in monitor	Dell U2414H	www.overclockers.co.uk	Issue 129, p43	£189
	27in 2,560 x 1,440 FreeSync monitor	Acer XF270HU	www.overclockers.co.uk	Issue 155, p46	£400
	27in 2,560 x 1,440 G-Sync monitor	Asus ROG Swift PG279Q	www.scan.co.uk	Issue 155, p48	£670
	27in 4K G-Sync monitor	ViewSonic XG2700-4K UPDATED	www.amazon.co.uk	Issue 157, p26	£480
	27in 4K FreeSync monitor	Dell UltraSharp UP2715K	www.scan.co.uk	Issue 151, p44	£755
	34in ultra-wide curved G-Sync monitor	Asus ROG Swift PG348Q	www.cclonline.com	Issue 157, p42	£1,000

Peripherals

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Mechanical gaming keyboard	Cooler Master MasterKeys Pro S (Pro L version recommended if you need a numeric keypad)	www.box.co.uk	Issue 152, p44	£100
	Premium mechanical gaming keyboard	Corsair Gaming K70 RGB Rapidfire	www.scan.co.uk	Issue 154, p21	£150
	Budget gaming mouse	Cooler Master Xornet II	www.box.co.uk	Issue 149, p28	£19
	Gaming mouse	Logitech G402 Hyperion Fury	www.scan.co.uk	Issue 139, p53	£50
	Ambidextrous gaming mouse	Roccat Kova	www.box.co.uk	Issue 150, p28	£50
	MMO gaming mouse	Corsair Scimitar RGB	www.box.co.uk	Issue 150, p17	£60
	Wireless gaming mouse	SteelSeries Sensei Wireless	www.box.co.uk	Issue 139, p61	£100

Audio

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	PCI-E sound card	Asus Strix Raid DLX	www.scan.co.uk	Issue 148, p28	£162
	2.1 speakers	Acoustic Energy Aego M	www.amazon.co.uk	Issue 142, p52	£125
	Soundbar	Razer Leviathan	www.overclockers.co.uk	Issue 142, p57	£160
	Headset	HyperX Cloud II	www.scan.co.uk	Issue 142, p46	£66
	Surround-sound headset	Asus Strix 7.1	www.shop.bt.com	Issue 142, p43	£149

Systems

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Quiet gaming PC	Scan 3XS Z170 Vengeance	www.scan.co.uk	Issue 151, p60	c.£1,500
	Dream PC	Scan 3XS Barracuda	www.scan.co.uk	Issue 145, p58	c.£9,499
	Sub-£2,000 gaming PC	Scan 3XS Z170 Vengeance 1080 GL	www.scan.co.uk	Issue 155, p62	c.£1,950
	Mini-ITX gaming PC	Scan 3XS Z170 Nanu Vengeance Fluid UPDATED	www.scan.co.uk	Issue 157, p62	£2,400
	Premium mini-ITX PC	Overclockers 8Pack Asteroid	www.overclockers.co.uk	Issue 154, p56	c.£3,990
	Premium PC	Scan 3XS X99 Carbon Fluid GL SLI	www.scan.co.uk	Issue 156, p64	c.£4,100
	Water-cooled PC	Overclockers Infin8 Toxicity	www.overclockers.co.uk	Issue 150, p58	c.£3,414
	Gaming laptop	CyberPower Fangbook 4 SK-X17	www.cyberpowersystem.co.uk	Issue 152, p30	c.£1,909
	Thin and light gaming laptop	Scan 3XS LG15 Vengeance G-Sync	www.scan.co.uk	Issue 153, p51	c.£1,480

Games



Featured this month

Inverse look p75 / Mirror's Edge: Catalyst p76 / The Witcher 3: Blood & Wine p78 /
Duskers p78 / Sherlock Holmes: The Devil's Daughter p80 /
The engine room – Total War: Warhammer p82 / Indie corner p84



RICK LANE / INVERSE LOOK

MMORE OR LESS?

Rick Lane ponders the future of the genre that World of Warcraft has ruled for over a decade

So far, 2016 has been a fantastic year for games, but there's one event from the last six months that saddened me. Earlier this year, Daybreak Games (formerly Sony Online Entertainment) cancelled EverQuest Next – the most exciting MMORPG to be unveiled in years.

The second sequel to the game that laid the template for all MMORPGs, EverQuest Next planned to shake up the genre with environments that the player could manipulate to extreme levels. Battles with monsters could create huge craters and valleys in the terrain, and players could found their own cities on the map. It was even possible to dig straight through the earth and enter an underground realm populated by powerful demons.

Daybreak claimed it cancelled EverQuest Next because it simply 'wasn't fun', but the termination of the project seemed like a bell tolling for the whole genre. Despite dozens of MMOs being released in the last decade, World of Warcraft remains the undisputed champion. What's more, many of the games that aimed to challenge Blizzard's online titan, either by improving upon WoW's template or attempting to offer something different, either fell on their sword or dwindled slowly into obscurity. Star Wars Galaxies, City of Heroes, The Matrix: Online, Tabula Rasa and Hellgate: London are just a few of the challengers that failed to assume Warcraft's throne.

The many high-profile failures, combined with the inability to oust World of Warcraft from its lofty position, has led to a general theory that the MMO genre is in decline, but it really depends on your perspective. While many MMOs have fallen by the wayside, equally as many have survived and prospered. For fantasy MMORPGs alone, the likes of Lord of the Rings

Online, Guild Wars 2, Tera, Rift, and The Elder Scrolls Online are all in rude health – a game isn't doing badly just because it doesn't have ten million players.

In truth, the MMO genre is ticking over well enough, but that's all it's doing. Since World of Warcraft's launch, there hasn't been a game that's managed to successfully evolve the MMO genre in a meaningful way. Even the fantastic Planetside 2 is based on a decade-old idea. There are various reasons for this situation. Choosing to develop an MMO is a big risk, which requires a huge budget, so most developers tend to play it safe, and changing the rulebook isn't easy when you're also trying to support a consistent game world for potentially millions of players.

However, I believe the main reason for the lack of a revolutionary new MMO is simply that the major selling point of MMOs – thousands of players occupying the same world – is no longer an exciting draw. In fact, with the toxic nature of large parts of modern internet culture, for many people, it may even be considered a drawback.

Instead, multiplayer gaming as a whole has gone down a different path, focusing on tailored experiences for smaller groups of players. The likes of Destiny and The Division offer the same large-scale, open-world exploration of MMOs, but they allow you to explore the game world with a small group of friends rather than a large number of random people you don't care about.

These days, a multiplayer game that offers a safer, more personalised space is immeasurably more preferable to a vast, busy and unpredictable online wilderness. If MMOs are going to flourish again, this obstacle needs to be overcome, and that won't be easy. **PCP**

A game isn't doing badly just because it doesn't have ten million players

Rick Lane is Custom PC's games editor. [@Rick_Lane](#)

Mirror's Edge: Catalyst / £50 inc VAT

DEVELOPER DICE / PUBLISHER EA / WEBSITE www.mirrorsedge.com



The original Mirror's Edge was a beautiful but flawed gem. A first-person game that eschewed traditional gunplay in favour of speedy parkour and acrobatic platforming, which took place in one of the most distinctive virtual environments ever created, Mirror's Edge was hampered by its brevity, strictly linear progression and inability to fully let go of firearms. Indeed, the great irony was that it was a free-running game that never truly embraced freedom.

Eight years on, DICE has finally followed up with Mirror's Edge: Catalyst, a reboot with a truly open world. It's the game Mirror's Edge should have been almost a decade ago, a beautifully fluid first-person platformer with a palpable sense of freedom and adventure. Unfortunately, though, its open-world template has been eclipsed in the lengthy gap between the two titles.

Rather than a direct sequel, Catalyst retells the story of the original, while expanding upon the tale of its protagonist, Faith Connors. Faith is a Runner, an illegal courier who

delivers messages and items along the City of Glass' rooftops. Using this underground (well, overground) railroad, the Runners evade the watchful electronic eyes of the Conglomerate, the oppressive corporate government that runs the

city. Newly released from prison, Faith soon becomes embroiled in a conspiracy involving local crime lords and Glass' private police force, KrugerSec.

The story does the job, although the rebelliousness of both the Runners and the more militant rogue faction Black November is distinctly adolescent, while the true nature of the conspiracy is hilariously silly. That said, aside from an oddly flat performance by the actor playing Faith, the game is written and voiced well enough to keep you engaged.

Of course, Mirror's Edge is fundamentally about movement and the traversal of its remarkable environment. Faith's parkour moves remain largely unchanged from the first game, so anyone familiar with Mirror's Edge will feel

It's delightfully grounding to look down and see your own feet

comfortable in Catalyst. Faith is a wonderful avatar to inhabit, being light, fast and agile while sporting a convincing physical presence. It's delightfully grounding to look down and see your own feet, and Mirror's Edge carries this virtual sense of self to its most extreme conclusion. Whether

she's lifting herself onto a platform, reaching for a ledge or simply pumping her arms as she runs, you're always aware of Faith's body surrounding you, and the effect is convincing.

The audio design is a significant contributor here. The sound of Faith's feet pounding across gravel or squeaking along a glass floor, from the clang as she grabs a drainpipe after leaping from a roof, to the sense of impact after dropping from a height, tucking and rolling to absorb the force of the landing. What's more, the controls do a fine job of balancing agency with simplicity. Faith grabs ledges and mantles obstacles automatically, but you control when she moves, jumps, ducks and slides. One of the most important aspects of Mirror's Edge is timing your rolls when landing, or

Faith will stumble and break her flow of movement. At times, Mirror's Edge feels like a rhythm-action game, only you have much greater control over the environmental cues to which you want to respond.

Catalyst's open world also offers much more space to become acquainted with Faith's abilities than the first game. Glass' bleached rooftops and glass skyscrapers dazzle in the daytime sun, and glow with neon when darkness arrives. Look out from a rooftop and you'll see a city bustling with life. Streets are packed with traffic, high-speed trains bullet along their tracks, smartly dressed businessmen converse in glass-panelled offices





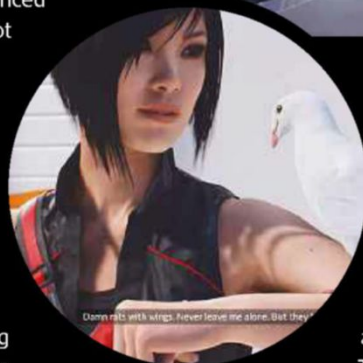
and formidable KrugerSec VTOLs patrol the skies. Each area of the city has its own unique aesthetic, from the yellow tape and orange cargo containers of the construction site, to the glistening rivers and sleek yachts of Regatta Bay.

Nevertheless, the complex, jumbled nature of the game's rooftop world means an inexperienced runner could easily become lost, were it not for Faith's sublime Runner Vision, which highlights routes and traversable objects in bright red. While these routes will always get you to your destination, though, exploring may reveal a faster or more efficient road.

The central joy of Catalyst derives from simply moving around the city. It doesn't matter whether you're on a mission, doing a side activity or just running around; the act of running is always thrilling and engaging. It's a testament to the developer that, although there's a fast-travel mode, we never once used it. Exploring the nooks and crannies of Glass is just too much fun.

Even the game's combat system is all about momentum, kicking KrugerSec Patrols into objects, leaping from heights or dashing along walls to initiate powerful attacks, or using lighter attacks designed to get enemies out of your way and keep your momentum going.

First-person melee combat is tricky to implement, and DICE largely does an excellent job. There are two problems, however. The first is that, if you're forced to stop, you become extremely vulnerable, and it can be difficult to regain that lost momentum. The second is that sometimes the campaign will force you into fights that go on for far too long, although that's only an occasional issue.



Catalyst's biggest problem, however, is that DICE struggles to fill its open world with interesting activities. Aside from the Grid Node missions, where Faith must traverse a large and complex server bank in order to hack it, these activities don't feel well integrated into the game world; most are typical cut-and-paste distractions. There are several types of Delivery

mission, all of which are similar, and there are Distraction missions where you give KrugerSec the runaround while other Runners go about their business, and there are opportunities to destroy KrugerSec radio antennae. However, your reward for completing these activities is the game's intangible Scrip currency, which is used to unlock a meagre selection of character upgrades.

DICE has clearly spent a lot of time looking back at what went wrong in the original *Mirror's Edge*, to the point that Catalyst often feels like it was developed in a bubble that ignored how open-world gaming was evolving around it. Fortunately, the original concept was so far ahead of its time that Catalyst still feels strikingly modern – it has its flaws, but it's still a giant, thrilling platforming puzzle in an open world that's a genuine work of environmental art.

RICK LANE

OVERALL SCORE

80%

/ VERDICT

Better late than never, Catalyst provides the open-world, free-running thrills that the original *Mirror's Edge* failed to deliver, albeit with a well-worn template.

The Witcher 3: Blood & Wine / £16 inc VAT



DEVELOPER CDProjekt RED / PUBLISHER CDProjekt / WEBSITE www.thewitcher.com



OVERALL SCORE
94%

/ VERDICT

Fun yet gripping, silly yet terrifying, vast yet detailed, Blood & Wine is a fitting expansion pack to last year's best game.

Having created the best RPG in years, CDProjekt continues its stunning run of form with Blood & Wine, The Witcher III's second expansion pack. It represents the studio's last dalliance with the charmingly grizzled Geralt of Rivia, and as a parting gift to the character that made the developer's name, CDProjekt couldn't have done better.

Blood & Wine sees Geralt travel to the land of Toussaint, where the Duchess Anna Henrietta has contracted him to destroy the Beast of Beauclair, a powerful monster who has brutally slaughtered three noblemen without even being seen. Of course, what begins as a straightforward monster hunt soon evolves into a complex conspiracy that threatens to tear out the aristocratic heart of the nation.

Despite the grim premise, Blood and Wine possesses a lighter and more humorous tone than the main game. Toussaint is almost a parody of the chivalric medieval realm, a gorgeous landscape dotted by colourful chateaus and sun-drenched vineyards. Its roads are safeguarded by Knights-Errent, who exist solely to embark upon epic quests and noble deeds. The central city of Beauclair is dominated by a massive



fairytale castle which can be seen from almost any point in the expansion's remarkably vast open world.

CDProjekt clearly revels in playing with this exaggerated fantasy realm, and even the missions get in on the act. Quests see Geralt searching for the stolen genitals of a statue, or partaking in a grand tournament in order to investigate the strange behaviour of the fair maiden at its centre.

While there's plenty of fun and games in Blood & Wine, though, the darker side that has defined the series remains

Duskers / £14.99 inc VAT



DEVELOPER Misfits Attic / PUBLISHER Misfits Attic / WEBSITE <http://duskers.misfits-attic.com>

A survival horror game unlike any other, Duskers casts you as the lone spacecraft pilot in a dying galaxy, scavenging derelict ships and stations for fuel and equipment. While most survival games would have you exploring these floating metal husks directly, though, you instead experience the world beyond your spacecraft through the video feeds of remote-controlled drones.

What makes Duskers so interesting is how it prioritises immersion from both an aesthetic and systemic perspective. The game is entirely controlled using the keyboard, and the on-screen menus and readouts are

presented with a beautiful retro-futurist design, as if you're sitting at a computer terminal from Star Wars or Alien.

When you locate a 'derelict' to explore, you can send up to four drones into it, each of which can be customised with different abilities. Presented from a top-down perspective, Duskers' drones are either controlled directly using the arrow keys, whereby you can watch them through an abstracted video-feed, or via the command interface on the ship schematic screen. Typing simple commands such as 'navigate 1r3', will direct your first drone to room r3. 'Gather all' will instruct your drone to collect all the scrap and fuel in

OVERALL SCORE
90%

/ VERDICT

Blending captivating emergent play with brilliant sci-fi horror, Duskers is a survival game to savour.



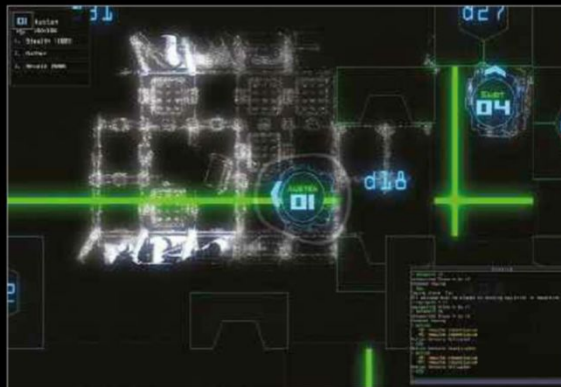
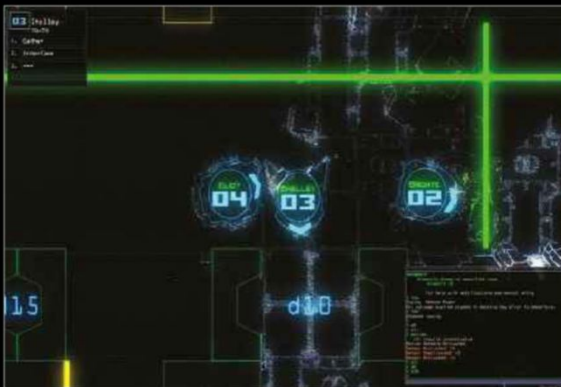


just beneath the surface. The choice and consequence systems at which CDProjekt excels are on fine form, and if Geralt fumbles in his juggling of the various powerful factions at play in Toussaint, the results can be dire. Blood & Wine also sees Geralt square off against his most challenging opponents yet.

Nasty new enemies such as Shaelmaar and Giant Centipedes accompany redesigned old favourites, such as Barghests and the formidable Bruxae, to test Geralt's swordplay to the limit.

Alongside the usual quests, treasure hunts and exploration opportunities, Geralt gets a home of his own, and a new range of mutation-based abilities to unlock. The only downside is the relative dearth of Witcher Contracts, the monster hunts that provided some of the most fun missions of the main game. Blood & Wine is a successful final act for The Witcher, generous almost to a fault and encapsulating all the elements that made Wild Hunt such a triumph. Indeed, the worst we can say about it is that it ends.

RICK LANE



a room, while 'Motion' will activate the motion tracker on any drone which has it installed.

It's in this latter aspect where Duskers elevates from being a gimmicky survival game into a terrifying galactic adventure. You might be the last surviving human in the galaxy, but that doesn't mean you're alone. Before you dock with a ship or station, you receive a brief summary of the structure's overall condition, and while you can use devices such as motion trackers to roughly assess which rooms aren't empty, you can never be entirely sure what you might find. Some scanned rooms return inconclusive results, and the only way to determine whether there's something lurking inside is by opening the doors and entering.

As a result, exploring these abandoned vessels becomes an incredibly tense experience, as you try to balance the

safety of your drones with your need to scavenge resources. Open the wrong door and you could cause a horde of alien monstrosities to pour out onto your drones, or accidentally blast one of your friendly robots out of an airlock into space. Also, some derelicts are structurally unstable, which can cause effects, from your video feed intermittently cutting out to deadly radiation leaks.

Duskers is entirely procedurally generated, so the experience is different every time and some games are more punishing than others. Also, while Duskers is effective at building tension, some of the monster designs can be deflating when revealed. Nevertheless, Duskers' ingenious presentation and innovative survival mechanics makes it one of this year's indie highlights.

RICK LANE



Sherlock Holmes: The Devil's Daughter / £27 inc VAT

DEVELOPER Frogwares / **PUBLISHER** Bigben Interactive / **WEBSITE** <http://sherlockholmes-games.com>



OVERALL SCORE
25%

/ VERDICT

A terrible mishmash of ideas that never once approaches being enjoyable. The Devil's Daughter makes Guy Ritchie's Sherlock Holmes look brilliant.

After years developing Sherlock Holmes adventure games in relative obscurity, Frogwares was catapulted into the limelight in 2014 with the critically acclaimed Crimes and Punishments. The Devil's Daughter is the follow-up and the studio's most ambitious Sherlock Holmes game to date. Sadly, like the bumbling Inspector Lestrade, The Devil's Daughter's ambition massively exceeds its capability, collapsing under its own ludicrous weight.

Assuming the role of the world's most famous detective, the player must solve a series of mysteries ranging from tracking down the missing father of a poor street urchin, to deciphering an Aztec curse in order to find a murderer. As a detective game, the Devil's Daughter has potential. Its deduction system lets you enter Holmes' mind and connect clues to form theories about the case. In addition, Holmes can form character portraits by observing people's clothes and distinguishing features, and he can counter false statements made by suspects and witnesses by presenting them with contradicting evidence.

They're decent ideas, but they don't work that well; you're limited to following the developer's often sketchy logic rather than experimenting with your own, so finding the 'correct' answer is often down to guesswork. The character portrait system is also inconsistent, sometimes letting you make deductions about a person, while other times only identifying

distinguishing features. What's more, the ability to contradict statements made by suspects and witnesses seems to occur almost randomly.

Nevertheless, if Frogwares focused on these concepts, The Devil's Daughter might be worth playing. Instead, these ideas are merely seasoning atop a pile of mechanics so undercooked you could catch salmonella from them. The Devil's Daughter includes stealth sections, chase sequences, puzzle platforming, cover shooting and enough half-baked mini-games to corrupt a smartphone app store. Almost every one of these ideas has been given half the attention needed to make it enjoyable.

For example, there's a section during which you assume control of Toby, Holmes' basset hound, to follow a scent. It lasts two minutes, yet in that time, the game manages to infuriate you with the dog's abysmal tank controls and distinct lack of animation. In another section, Holmes must eavesdrop on 'conversations', which amount to an individual sentence uttered by only one party, and happen to provide exactly the information Holmes is seeking.

If you want to play an entertaining detective game, try LA Noire or even The Witcher 3. If you want a good Sherlock Holmes experience, try the US TV show Elementary or the books. If you want to torture yourself for several hours, we recommend sliding a needle down the back of your fingernail. Whatever you do, avoid the Devil's Daughter, like, well, the Devil's Daughter.

RICK LANE

THE

FREE! HEALTH / FITNESS / ACTIVITY / MOTIVATION / REWARD
COACH

EFFECT

DO SOMETHING



The new health & fitness magazine
FREE EVERY WEDNESDAY

Find out where at coachmag.co.uk

FITTER+HEALTHIER+HAPPIER

#COACHEFFECT

RICK LANE / THE ENGINE ROOM

Total War: Warhammer

From using multiple CPU cores to abandoning DirectX 10, Rick Lane talks to Creative Assembly about Warhammer's technical challenges

With its shift from historically authentic warfare to outright fantastical conflict, Total War: Warhammer marks the biggest evolution in the Total War series since the introduction of naval and artillery-based battles in Empire: Total War. From giant units that can straddle the ranks of armies, to devastating magical abilities, Total War: Warhammer introduces dozens of heretofore unseen systems to the venerable strategy franchise.

Such radical alterations posed a formidable design challenge, but Total War: Warhammer is also a fascinating game from a technical perspective. While Total War has always been at the technical forefront for strategy games, the engine of Rome II simply wasn't equipped for what the developers had in mind for Warhammer.

'The Total War franchise has a long and rich history, and so too does the engine,' says Tamás Rábel, lead engine programmer on Total War: Warhammer. 'While it has been revised and improved upon throughout its lifespan, certain parts of it have served us particularly well and have remained very close to their original design from ten years ago.'

Indeed, there have been many bells and whistles added to Total War over the years, but the central idea has always revolved around large scale, ground-based pitched battles. However, the Warhammer universe shattered many of the



Underground battles have their own lighting system to simulate the feel of a dark, enclosed space

series' previous conventions with the diversity of its units, factions and mechanics.

In fact, Warhammer's unit roster is so diverse that Creative Assembly had to think up an entirely new way of animating battles. 'In the past, we had authored what we call matched animations; an animation that's created to animate two or more characters engaging in choreographed combat,' says Rábel. 'We quickly realised this wouldn't be an option for Warhammer, since there were simply too many permutations (dwarf versus dwarf, dwarf versus man, dwarf versus giant and so on), which would lead to more animation data than we could possibly fit in the game.'

'So we moved to a system of separate attack and reaction animations. We actually found this

led to more reactive and visceral combat, and made many-to-one combat feel much more compelling.'

Specific types of units also posed problems for how the game traditionally rendered its battles. The giant units introduced in Warhammer, which are 10-20 times the size of the war elephants featured in previous games, forced the team to rethink certain aspects of collision detection and other areas of animation. Warhammer also added flying units to a game that has hitherto been entirely concentrated on terrestrial combat.

'We had to spend a considerable amount of time prototyping different approaches,' says Rábel on the subject of flying units. 'We needed the units to be able to move and fight in a consistent way with land units, while also ensuring that



The sheer amount of combat permutation meant the developer had to rework its animation system for battles

their altitude could be easily understood by the player. They needed to look organic and alive while also maintaining enough of a formation to avoid becoming confusing. We also had to change the behaviour of land units to enable interactions with flying units, such as blowing them out of the sky with missile weapons.'

The changes to how combat works in Total War isn't restricted to units either. The introduction of magic allows players to deploy powerful, highly destructive spells which, if used tactically, can alter the tide of battle. Implementing these dazzling abilities was a little easier than the newer unit types, thanks to improvements made to the particle engine for the Rome II expansion – Attila.

'Attila required a lot more particles than Rome II, since razing and burning everything was a significant part of its design,' Rábel notes. 'To achieve that number of particles, we moved the particle simulation pipeline from the CPU to the GPU. As we've dropped DirectX 10 support on Warhammer, we've been able to move particle simulation to compute shaders, further improving performance. We also made significant optimisations to the particle fill rate to accommodate the increased number of particles.'

A far tougher challenge from a rendering perspective came from the game's subterranean battles, a vital component for representing the underground society of the Dwarven faction. 'This is the first time we've placed battles in an enclosed environment without any sky or sunlight, which was the primary source of light and lighting



variations before,' says Rábel. 'We needed to make sure we captured variations in ambient lighting across the whole map, and eventually solved this problem by using a form of ambient occlusion that can deal with both small and large-scale occlusions, essentially taking the place of shadows in the underground battles.'

If the sheer diversity of Total War: Warhammer made it challenging to update the stronger elements of the series, how did it affect its weaker areas? Total War has always struggled with enemy AI in battles,

The newly introduced flying units required several prototypes of mechanics

Giant units necessitated adjustments to the way in which animations and collisions work



and the expanded range of potential scenarios in Warhammer meant the developers had to introduce a new method of teaching the AI to control armies. 'We created a set of designer-driven tags that were placed on each unit in order to teach the AI how to use that unit in battle,' Rábel says. 'This way, the designers could create units with non-standard battle roles, such as missile troops that are good in melee combat, or powerful wizards that avoid combat, and the

AI would use them as intended.'

Performance has been a bugbear for more recent entries in the series too, particularly Rome II, which suffered from a troubled launch in terms of technical issues. In addition, Total War: Warhammer has the largest battles in the series to date, partly thanks to the huge swarm armies of the

Vampire Count faction. To help tackle this problem, Rábel says, 'The most important change on the CPU side was to run the game logic and rendering parallel on multiple cores. This alone had a huge impact on performance. Dropping DirectX 10 on the GPU side also meant we could optimise and move certain parts of the pipeline to compute shaders, and we also revised almost all the large systems in the game, from terrain rendering to lighting.'

The pairing of Total War and Warhammer always seemed like a match made in heaven, but Rábel's words highlight that fitting the pieces together was far from easy. Nevertheless, the results of Creative Assembly's efforts are plain to see. Total War: Warhammer is the most exciting and tactically rewarding entry in the series to date. The diversity of the Warhammer universe has catalysed the developer's ambitions, and its attempts to tackle the challenge of representing large-scale fantasy combat has resulted in some fascinating innovations to the game's base tech. **GPU**



INDIECORNER

Rick Lane introduces five unique and innovative games being created by entirely independent developers



We Happy Few

DEVELOPER Compulsion Games / **RELEASE** Out now (Early Access)

We Happy Few is an action-adventure set in an alternate version of 1960s Britain – one that's been ripped apart by war and stitched roughly back together by an oppressive government. The lynchpin of the new regime's power is a drug called Joy, which puts the population in a default state of soporific happiness, warping their perception of the world into one of rainbow colours and smiling faces.

The scales have fallen from the eyes of your character, though, and you're consequently trying to escape your Joy-addled hometown of Wellington Wells. Play-wise, it looks like an immersive sim combined with survival horror, and you'll be able to choose how you deal with scenarios, opting for stealth or a more combat-orientated approach.

While the developer promises a narrative-driven experience, the levels are procedurally generated, so you'll never experience the game the same way twice. Also, a large component of the game involves learning how to hide in plain sight. The inhabitants of Wellington Wells will attack anyone they perceive to be 'Downers' – people who are off their Joy, so you need to act like the narcotically cheerful populace. You could just take Joy yourself, but it will radically alter your perception of the game world.



Subnautica

DEVELOPER Unknown World Entertainment / **RELEASE** Out now (Early Access)

As you can probably guess from the title, Subnautica is a survival game that takes place entirely underwater. Specifically, you're stranded on an oceanic alien planet, and the closest you'll get to dry land is inside your subaquatic life pod.

In its broader structure, Subnautica is a typical survival game. You must explore this underwater realm, scavenging supplies, crafting new items and expanding your base in order to increase your chances of staying alive. However, developer Unknown Worlds adds a couple of interesting elements to this framework. As expected, you can both hunt and be hunted by the game's aquatic wildlife, particularly at night when the nastier creatures emerge, but you can also use these sea creatures to your advantage, distracting a larger monster with another form of prey.

In addition, Subnautica's sandy seafloor is rendered using a dynamic Voxel terrain system, which means it can be easily deformed. You can use this system to dig caves to hide treasure or create little supply caches, while impacts and underwater explosions will alter how the world looks. Subnautica also benefits from having a fantastic visual design, a game world teeming with life and unique locations to explore.



KeeperRL

DEVELOPER Michal Brzowski / **RELEASE** Out now (Early Access)

KeeperRL looks set to take the room-building, minion-minding, hero-bothering structure of Peter Molyneux's classic *Dungeon Keeper*, and adding a sprinkling of Dwarf Fortress to the proceedings. Whereas *Dungeon Keeper* saw you building multiple underground lairs across a series of missions, *KeeperRL* takes place in a single, large, procedurally generated world. Your Keeper has a physical presence in this world, and if they're killed, it's game over.

However, between you and mortality sits a deadly dungeon of your own devising, filled with all manner of monsters who will do your bidding (provided they're sufficiently fed and regularly paid). As you expand your subterranean sanctuary, overground factions such as Dwarves, spiders or dryads will take a growing interest in your dungeon. Some may attempt to wipe you off the map, but others may choose to aid or ally with you.

In this fashion, *KeeperRL* enables broader emergent stories than *Dungeon Keeper*. What's more, should you succeed in wiping all your enemies off the map, your completed Dungeon is uploaded to the Net and can be played from the other side by player heroes. *KeeperRL* may not have the same level of humour and imagination as *Dungeon Keeper*, but it remains an intriguing genre mashup.



Phoenix Point

DEVELOPER Julian Gollop / **RELEASE** TBA

Phoenix Point sees *UFO: Enemy Unknown* creator, Julian Gollop, taking the improvements Firaxis made to *UFO* in its *XCOM* update, then infusing them with a new theme and mechanics that expand on ideas from *UFO*'s sequels, *Terror from the Deep* and *XCOM: Apocalypse*.

As expected, players control a Special Forces organisation attempting to save the world, but the threat you're battling is a virus spreading across the earth, infecting and radically mutating any lifeform it finds. The virus has multiple effects, cloaking enemies on the strategic map and procedurally altering their physical makeup. Consequently, players will never know precisely what enemies they're up against, and those enemies may mutate depending on how players deal with them, growing in size or developing thicker armour.

Players must also attempt to ally with the pockets of human resistance scattered across the map, but these factions won't join up with you just to save the world. Each faction has its own beliefs and goals, and you'll have to find ways of working with them in order to get the factions on-side. *UFO: Enemy Unknown* is one of the most influential games ever, and *XCOM* is a modern classic, so it's exciting to see the original creator exploring these renewed ideas.

House of the Dying Sun

DEVELOPER Marauder Interactive LLC / **RELEASE** Out now (Early Access)

A space shooter that aims to bring back the thrilling dogfights seen in the classic *X-Wing* and *Tie Fighter* games of the 1990s, *House of the Dying Sun* places you in the cockpit of a Royal Guardsman of a recently assassinated Emperor. Your sole mission is to hunt down the anti-Imperial aggressors who killed your Emperor and give them cause to seriously regret their regicide.

House of the Dying Sun's emphasis is on providing plenty of spectacular space combat throughout its 14 mission campaigns, but it also stands out in one important way. You're accompanied by a squadron of other Royal Guards, and you can issue them commands via a tactical map. It's even possible to switch to other fighters and assume direct control over them in



the middle of a battle, enabling you to perform complex manoeuvres to outwit as well as outgun your opponents.

While *House of the Dying Sun* is only available in Early Access format, the game's campaign is already feature-complete, with the developer's remaining time dedicated to tweaking and refining the core game. **8/10**



PC BUILDING

Masterclass

From installing components, through setting up cooling to tidying cables, Ben Hardwidge shows you how to assemble a PC like a pro

There are plenty of smug tech-heads who will tell you that building a PC is just like assembling a Lego kit these days, and while they're right that PC building is certainly easier than it was 20 years ago, that doesn't mean anyone can just slot all the bits together and magically build a great PC. Unlike a Legokit, your box of PC components won't come with a full set of easy-to-follow instructions, telling you which slots to use for which components, where to put your

fans, which ports to use, where you put all those cables and how you make a PC that looks like it was built by a pro.

That's where we can give you a helping hand. Whether you're considering building your first PC, or if you've built a couple of machines already but want some tips and tricks, there will be something for you in our complete masterclass. We'll take you through the whole process from start to finish, giving you a foundation from which to build a great PC.



STARTING OFF

Whether or not you've built a PC before, your first job is to choose your components. We're mainly going to focus on building in this feature, rather than giving you a shopping list, but there are a few key factors to consider when buying your bits and pieces. A good place to start is our Elite list (see p64), which lists the components you need to build well-rounded PCs for various budgets.

Begin by choosing your **processor**, which will be manufactured by Intel or AMD. The former currently has the best CPU core architectures in terms of performance, efficiency, features and bang per buck, although AMD's new Zen architecture is due for launch in the next few months and may change all that. We're going to focus on Intel setups in this feature, although a lot of the same principles will apply to AMD systems, and we'll cover any major differences when it comes to AMD CPUs.

If you want to build an all-purpose PC for gaming then Intel's LGA1151

SkyLake CPUs are your best bet – they have fewer cores than LGA2011-v3 chips, but generally higher clock speeds. If you buy a K-series CPU then you'll also be able to overclock it (increasing the speed of the CPU beyond its

stock settings). We're using a Core i5-6600K Skylake CPU for our example build this month. If, on the other hand, you use a lot of heavily multi-threaded software that makes good use of multiple CPU cores, perhaps for

workstation rendering or video encoding, then Intel's LGA2011-v3 Broadwell-E CPUs will serve you better.

You'll then need to choose your motherboard, which has to match your chosen CPU's socket and also have a chipset that supports it. We recommend Intel's Z170 chipset for LGA1151 CPUs and Intel's X99 chipset for LGA2011-v3 CPUs. There are other

chipsets that work with these CPUs, but they often aren't as flexible in terms of overclocking. Again, our Elite list can help you out here. We're using an Asus Maximus VIII Hero Z170 for our example build.

The next step is the memory, and most modern PC setups use DDR4 RAM. You'll want a dual-channel kit with two matched modules for a Skylake system, or a quad-channel kit with four matched modules for a Broadwell-E PC. You'll need a CPU cooler too – many Intel CPU retail packages don't even come with a stock cooler any more, but Intel's stock coolers are generally comparatively noisy and inefficient compared with many third-party designs anyway. Most CPU coolers fit all the current CPU sockets, but it's always best to check first.

Unless you're happy to use the integrated graphics on a Skylake CPU (which will be good enough for work, media playback and very basic gaming, but

not much else), you'll need a graphics card too. We recommend a Radeon R9 380 for 1080p gaming, a Radeon RX480 for 2,560 x 1,440 gaming and a GeForce GTX 1070 or 1080 for 4K gaming. We're using an Asus Strix GTX 1070 card in our example.

You'll need a power supply (PSU) too, with sufficient power for your needs and enough connectors for your components. A 550W model will be fine for a standard PC with a CPU and single GPU, while a 750W model (or

above) will be better suited to a dual-GPU setup. It's also worth paying for a modular or semi-modular PSU, so you don't install any power cables you don't need, saving on cable clutter.

Then there's storage, and we recommend installing your operating system, commonly used programs and games on a solid state drive (SSD), and using a hard drive to store data such as large media files. It's also well worth considering using an M.2 NVMe PCI-E 3 SSD, which will not only cut down on cable clutter but also offer much quicker speeds than a standard SATA drive.

You'll need a case too, and for a tidy build, we thoroughly recommend buying a case with a cover for the PSU area, which will give you loads of space for storing cables.

Other key features to look for include rubber-lined cable-routing holes around the motherboard, rear-facing drive bays and 2.5in drive bays on the back of the motherboard tray, all of which will enable you to build a tidy rig.



TOOLS YOU'LL NEED



PHILLIPS/ CROSSHEAD SCREWDRIVER

If there's one tool you could consider essential for PC building, it's the humble crosshead screwdriver, sometimes called a Phillips screwdriver. While you see plenty of tool-free mounts in drive bays, any PC build will require a crosshead screwdriver at some point.



NEEDLE-NOSE PLIERS

Needle-nose pliers very often come in handy when you're building a PC. They're handy for tightening up nuts on CPU cooler mounts and unscrewing troublesome nuts and thumbscrews.



CABLE TIES

One of the most obvious differences

between a professional and an amateur PC build is the state of the cables inside. It isn't all about looks either – an interior free of clutter will have better airflow across the components, and will make upgrades and maintenance easier too.

If you want to keep your cables out the way, you'll need to tie them down, and while many cases offer a few Velcro straps to help, cable ties offer a

very cheap way to keep cables tidy almost anywhere.



PLASTIC CUTTERS

Plastic cutters, or wire cutters, are very handy for snipping the ends off cable ties, opening troublesome packaging and removing any ties from your power supply or case, giving you much more precision than scissors.

BUILDING YOUR PC

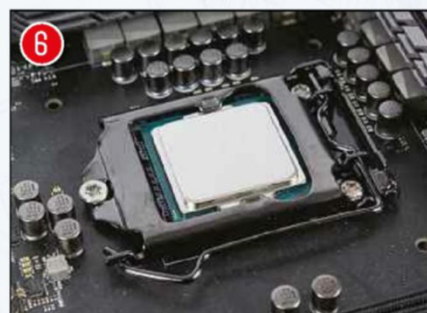
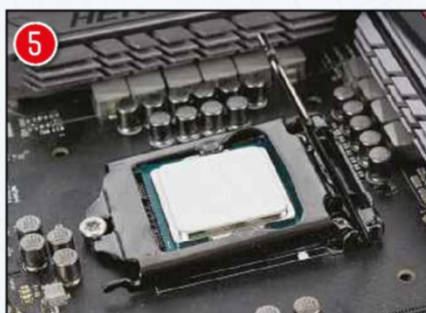
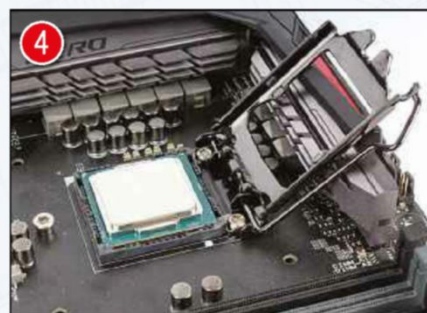
INSTALL CPU

We'll start this section with a warning, which is to be very careful with the pins in your motherboard's CPU socket. They're very delicate and it only takes a couple of bent pins in the wrong places to make your CPU unusable. When handling any computer components, you also need to make sure you're earthed to avoid static electricity. You can either wear an anti-static wrist strap, or when your finished PC is plugged into the mains, you can earth yourself by touching the metal on your case.

Once you've carefully removed your CPU from its packaging, push down on the front of the handle on the motherboard's CPU socket **1** and lift up the handle **2**. If there's a plastic cover on the CPU socket, now is the time to remove it. With the cover removed, check the indentations on the side of the CPU and the notches on the side of the socket.

You'll only be able to install the CPU in the correct orientation, and it will be obvious, but you don't want to risk damaging the pins and contacts by forcing the CPU into place back to front. Lower the CPU into the socket from the side **3**, gently slotting it into place **4**. You can then close the cover, sliding it under the screw in front of the socket **5**, push the latch handle back into place to lock the CPU into the socket **6**.

If you're installing an AMD CPU, the motherboard socket will have holes and the CPU will have pins. These pins aren't quite as fragile as the ones on Intel motherboard sockets, but you still don't want to end up bending any of them, so handle the CPU with care from the edges. In this case, the CPU's correct orientation is made obvious by the pin arrangement, as well as a triangle on both the socket and the underside of the CPU (pointing to Pin 1) that need to be aligned together. Lift the handle next to the socket to open up the holes for the pins, then gently lower the CPU into the socket. Once the CPU



is sitting firmly in place, push down the handle by the socket to secure it.

INSTALL MEMORY

Most Z170 motherboards have four memory slots, while most X99 motherboards have eight slots, although there are some exceptions on smaller and cheaper boards. For a Z170 motherboard, your dual-channel memory kit will come with two sticks, so on a standard motherboard, you'll likely have two slots left over for a future upgrade. Likewise,

you'll have four free slots on an average X99 board once you've installed a quad-channel kit with four sticks.

As such, you'll need to make sure your memory is installed in the right slots to enable quad-channel or dual-channel mode. These modes interleave the bandwidth of each module to increase the bandwidth further. Your motherboard manual will tell you which slots you need to use (usually the second and fourth slots, moving away from the CPU socket, on a Z170 board).





As with the CPU, the memory can only fit in the slot one way around, thanks to a notch on the bottom edge. To install a memory module, flip up the clip(s) – there may only be one clip, as on our board, with the other side fixed – on either side of the slot, put the DIMM in place **7** and push firmly on the top of the module **8** until the clip(s) on the sides flip back up again – don't force it. You can then push the clip(s) properly into their notches to secure the memory. Then do the same with the other module(s) **9**.

INSTALL CPU COOLER MOUNT

If you're using a basic air cooler for CPU, which has plastic push-plugs in each corner of its mount and no backplate, such as the cooler that comes in an Intel CPU retail box, you can skip this step. However, most decent third-party air coolers, and certainly all liquid-cooling systems, such as the NZXT Kraken X61 we're using here, require you to fit a backplate that sits underneath the CPU socket on the rear of the motherboard. An all-in-one liquid cooler will then likely require you to fit a mounting plate and thumbscrews to secure the cooler to the CPU.

Basically, the mount holds the cooler tight to the CPU, ensuring contact at all times, and a cooler with a backplate will help to properly secure your cooler from the rear. Air coolers usually have similar systems, but sometimes get a little more complicated around the CPU. Whichever cooler you use, follow the instructions carefully. At this stage, just install the backplate **10** and any basic mounts that go around the CPU socket, but don't install the cooler just yet.



APPLY THERMAL PASTE

Logic might dictate that squeezing two metal surfaces tightly together will automatically result in complete thermal conductivity between them, but today's silicon chips are filled with so many fast-switching, tiny transistors that they overheat very quickly if there are microscopic air bubbles between the CPU and the cooler. The surfaces of your CPU and your cooler's contact plate might look flat, but even the best manufacturing



techniques can't produce a 100 per cent completely flat metal surface. There will be tiny, microscopic pits in each surface, which effectively create insulators and prevent heat from being transferred from the CPU to your cooler's contact plate.

The solution to this problem is thermal interface material (TIM), also called thermal paste. Many CPU coolers include a coating of TIM screen printed onto the cooler's contact plate, ready for you to install, while others have a syringe of TIM for you to apply yourself. High-performance thermal paste is also available from third-party manufacturers such as Arctic, so you can always buy more paste if you run out.

If your CPU cooler has TIM pre-applied on the contact plate, you can skip this step, but if you need to apply the TIM yourself, it's best to apply a thin cross shape **11** **12**, from corner to corner, on the heatspreader (the metal part on top of your CPU – it sits on top of the much smaller chip underneath and spreads the heat over a wider area). The pressure from the mounting mechanism will then

automatically spread the TIM across the rest of the CPU. If you ever need to remove your TIM, you can use a lint-free cloth (you don't want any stray fibres getting between the CPU and the cooler) and a TIM-clean solution, such as Akasa TIM Clean, Arctic ArctiClean **13**, or some isopropyl alcohol from the chemist.

INSTALL CPU COOLER

If you have a swear box in your house then you should probably keep it nearby for this part, as installing CPU coolers, particularly air coolers with large heatsinks, is a notoriously fiddly and infuriating process. If you're installing an all-in-one liquid cooler, start by test-fitting the whole setup in your case.

The radiator section (the big black box with a grille on either side) needs to be screwed into a fan mount, or two fan mounts, depending on its size. There will usually be several options in your case, including both the front and back of the case, and some cases have mounts in the bottom too. Ideally, you want your radiator to be pushing hot air out of your case, acting as an exhaust, and most cases have a front-to-back airflow system, where fans pull air through the vents in the front or the bottom of the case, and expel it via fans pushing air out through the rear or the top of the case.

Start by test-fitting the radiator in these locations **14**, which will also give you an idea of the right way to mount the CPU cooler to the motherboard without stretching or squeezing the tubing too far. Fit the fans to the radiator first, following the instructions with your cooler, so you know exactly how much room is available. You ideally want the tubing kept out of the way of slots you might want to access, and clear of fan blades too.

If you're installing a traditional air cooler with a large tower heatsink, you'll also want to position it so that the fan pushes air towards the rear of the case. As a general rule, the rear of the fan (with the plastic bars in front of the blades) should face the rear of your case, and the front of the fan should face the front of the case. If this configuration isn't possible, then the next best alternative is to





point the fan's airflow towards the top of the case instead.

Once you've figured out how you're going to position your cooler, remove any plastic protective film from the cooler's base and line up the holes with the cooler's mounting bracket. Holding the cooler block in place, attach the thumbscrews and tighten them with your fingers **15**, starting with a little tightening in one corner, going to the opposite diagonal corner, then doing the same from the next corner. Keep tightening each corner until the cooler is securely in place. You can then hook up the fans' power plugs to your motherboard's CPU fan headers, and connect any other power connectors to the corresponding sockets on your power supply.

FIRST TEST

You should now have a basic, working PC system, so it's a good time to test it all before going any further. It's incredibly annoying to find out that your PC doesn't work once you've spent hours screwing it all into the

A GUIDE TO PSU POWER PLUGS



24-pin ATX connector (motherboard)



8-pin EPS 12V (motherboard near CPU socket)



SATA (hard disks, DVD drives and some CPU coolers)



Molex (fans, fan controllers, pumps)



PCI-E 6-pin and 8-pin (graphics cards)



3-pin and 4-pin fans (motherboard fan headers)

case and tidying the cables, so it's best to find out if you have a loose connection or perhaps even a faulty component now.

You'll need to start by putting your motherboard on a raised surface, in order to give you some room for your graphics card's backplate – the motherboard box will do this job perfectly. If you're using a graphics card, rather than the CPU's integrated graphics, remove the plastic cover on the main slot connector, if there is one, plug the card into the top 16x PCI-E slot **16** – the large slot that's

under the CPU socket, and plug a keyboard and mouse into the USB ports on the back of the motherboard too.

Before you go any further, now is also a good time to get to know all the various PSU power plugs and where you need to connect them (see box above).

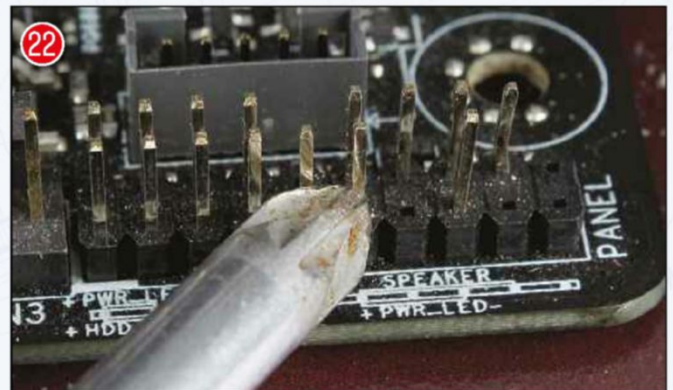
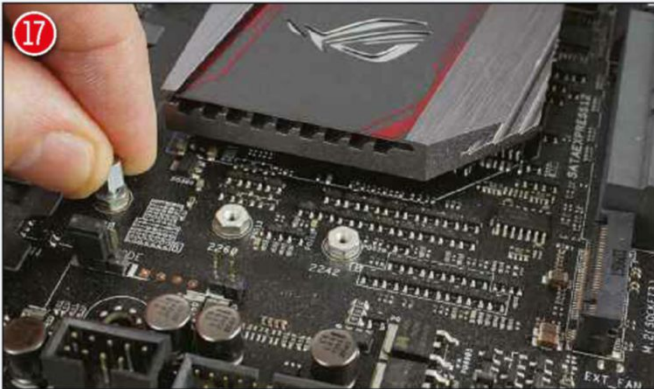
Hook up the 24-pin ATX and 8-pin EPS power plugs on your PSU to the sockets on your motherboard, and also connect the PCI-E power plugs to the sockets on your graphics card. While you're here, it's also worth plugging in any solid state drives and hard drives to make sure the motherboard detects them without any problems.

Connect any SATA drives to the SATA power connectors on your power supply, and use the SATA data cables (which will be supplied with your motherboard) to link the drives to the SATA ports on the motherboard. These ports are usually positioned on the bottom right of the board; connect any SSDs to the Intel-controlled SATA 6Gbps ports, as they'll be quicker than ports connected to third-party controllers. Your motherboard manual will tell you which ports are Intel SATA 6Gbps ones.

If you're using an M.2 SSD, plug it into your motherboard now. It won't need to be connected to the power supply. Firstly, find out the length of your SSD – it will be specified in a number such as 2260 or 2280.

There should be corresponding holes for your SSD's length on your motherboard, and your board should also come with a standoff and screw for M.2 SSD installation. If there isn't already a standoff in place, screw





your M.2 standoff into the right hole for your SSD's size **17**. After that, hold the SSD by the long edges, then insert the end with the metal contacts into the socket at a diagonal, with the top of the SSD pointing upwards **18**. Gently lower it into position, finally screwing it into place **19**, without overtightening the screw. Don't force the SSD into place – if you face significant resistance, then it may not be fully inserted into the socket, in which case remove it gently and retry it.

Finally, plug your monitor into one of your graphics card's outputs, depending on which type of cable and monitor you're using, or one of the motherboard's display outputs if you're not using a separate graphics card.

With all these parts connected, you should theoretically have a basic working system **20**. It won't look pretty – you'll probably have a big jumble of cables everywhere – but that

doesn't matter – you just want to check it all works at the moment. The next job is to plug the power supply into the mains, and flick its on switch – at this point, a couple of LEDs might light up on the motherboard to show power is connected but the PC isn't powered up yet, although not all motherboards do this. You now need to power on your skeleton PC to see if it works; however, at this point you can't use the power switch on your PC case.

If your motherboard has on-board power (sometimes called Start) and reset buttons, you can push the power button to start up your machine **21**. If not, you'll need to find the front panel header on your motherboard – a series of pins where you connect your case's power, reset, and LED cables for hard drive activity and power. Your motherboard manual will show you where to find it, but it's usually at the bottom of the motherboard, towards

the right. If you grab a small screwdriver, you'll be able to turn on your PC by placing it between the two power switch pins and shorting them out **22**.

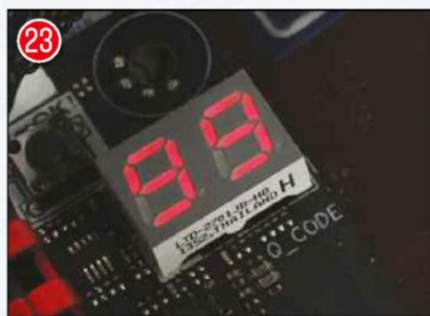
When your system boots, you should get a display on your monitor, in which case tap the Del key on your keyboard and you'll enter your motherboard's BIOS or EFI system – a piece of basic setup software for the motherboard. If you get this far then your core hardware is working.

TROUBLESHOOTING

If you end up with nothing on the screen, power off the system, and try removing the CPU, memory and graphics card and then reseating them. There may be a loose connection somewhere, or you may have a faulty component. Also make sure that all the power connectors for the motherboard and

graphics card are securely plugged in. If you still get no display after reseating your core components, then you'll need to diagnose the troublesome component.

Some motherboards have a POST (power on self test) code display **23**, usually with two digits, on the motherboard. If you have one, check the display with the guide in the motherboard manual to find out what's wrong. Some motherboards will also provide a series of beeps to diagnose POST problems – again, check the motherboard to diagnose the problem from the beeps. If you have a friend with a working PC, it's worth asking if you can try their components, one by one, to find the fault by process of elimination. Start with easily replaceable components first, such as the memory, then the graphics card and, finally, the CPU.



CHECK THE EFI

When you get into the BIOS or EFI system, there should be a basic information section that shows you which storage devices are connected to your PC. Make sure any solid state drives and hard drives are listed here – alternatively, they may be listed in the boot devices section. While you're here, make sure your motherboard is using the best communication protocols for your drives. If you have an NVMe M.2 drive, then it needs to be set to use the NVMe protocol, while any SATA SSDs or hard drives should use the AHCI protocol.

While you're here, check your CPU temperature, which will usually be in a section called 'health' or 'monitoring'. If it's above 50°C, and you're using a good third-party CPU cooler, it's too hot, so power off your system and check you've mounted the cooler correctly, removed any protective plastic film from the cooler base and also applied thermal paste. The temperature should ideally be below 40°C at average UK room temperature.

TEST-FIT PSU AND MOTHERBOARD

When you know your basic system is working, you're safe to start properly

mounting your gear in your case. Start by removing both the left and right side panels, and test-fitting your PSU and motherboard in the case, being very careful not to scrape the bottom of the motherboard on any metal – it only takes one circuit trace to break and your board could become unusable. With your PSU and motherboard in place, you can work out where your cables need to go and where you need to route them for your components.

This stage is crucial for the build, and it's worth taking some time to figure out where all your parts need to go. If your case has a cover for the PSU area, like ours, then you'll have an easier job with cable tidying, but either way it's worth carefully routing your cables and positioning your components.

CABLE ROUTING

Your case should have holes around the motherboard area, in some cases lined with rubber, to help you here. You need to run your PSU cables around the back of the motherboard, and push them back through the holes – this will help to clear the way for airflow in the case, while also giving you easy access to your expansion slots and ports.

If your case doesn't have a cover for the PSU area, it should have a large hole next to the PSU through which you can pass your cables. Route the EPS 12V cable through here, behind the motherboard and up to the top of the case. There should be a hole just above the top left of the motherboard – thread the plug through this hole and it will be in the right position to plug into the socket on your motherboard **24**.

With the 24-pin ATX connector, again route it through the large hole, then up and right, so you can push it through the hole next to the socket on your motherboard **25**. You'll then need to do the same with the graphics card power cables.

Finally, for the drives, you want to aim to keep your cables hidden. If your case has 2.5in bays for SSDs behind the motherboard tray, or in the PSU area (as with our case), use them instead of the normal drive bays at the



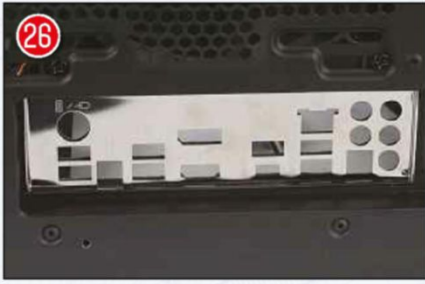
front – SSDs aren't nearly as prone to overheating as mechanical hard drives. If possible, mount your hard drives with their connectors facing the right side panel, and you can then route the SATA power cables behind the motherboard tray, out of sight.

If your hard drive bays position the hard drives horizontally, make use of the cable-routing holes by the motherboard to hide them as best possible.

You don't need to install the drives yet – just work out where you're going to put them. If you're using any components that also use SATA or Molex power cables, such as the pump for a liquid cooler, or an LED strip, use the cable-routing holes to thread these cables through to the right places too. Likewise, work out where the power cables for your case fans (and the fans on your radiator if you're using a liquid cooler) will go.

If your cables are long enough, or if you have extension cables, you'll be able to route the cables for rear and top fans through the holes above the motherboard, and then back to a waiting SATA or Molex power cable, or to an appropriate fan header on your motherboard. If your case has a fan controller, use this opportunity to work out where all the cables are going to go to and from it as well.





Keep any of these cables well away from the spinning fan blades.

You can also use the cable-routing holes for the SATA data cables on the right of the motherboard – thread them through the middle hole and then out of the bottom hole. You can then connect one end of a SATA cable to the SATA ports at the bottom of the board, and the other end to the hard drive, hiding most of the cable behind the motherboard tray.

PSUs nearly always have more connectors than you need, so if you have a modular PSU, you can save yourself some hassle here by only using the cables you need. If you have a non-modular PSU then you'll need to be clever about how you route them, especially if your case doesn't have a PSU cover. With a non-modular PSU, we recommend pushing all of the cables through the large cable-routing hole at the bottom of your case, and then tying them in place around various locations behind the motherboard.

Most cases have holes through which you can pass cable ties to hold them to the middle frame, which are handy for keeping cables tied together and holding them in place, out of sight. However, you also need to make sure you can still close the right side panel afterwards, so avoid routing any cables next to the side panel mounting point, and avoid bunching big cables up together – if you have a stack of thick cables on top of each other then the right side panel may not go back on.

Once you've worked out where all the cables are going, you can gauge if your cables are the right length. Most PSUs have decent-length cables now, but sometimes you still get cables that won't go all the way around to where you want them, particularly if you have a large case.

Don't worry if that happens though – extension cables are available from most computer retailers that will give you the length you need. You can get extensions with each wire individually sleeved too, meaning you can make even a cheap PSU with captive cables look like a fancy PSU with sleeved cables if you can hide the rest of the wires out of sight. Once you know where everything is going, secure your PSU in its



mount, using the four screws provided in your case's screw kit. In most current cases, the PSU should be positioned with its fan facing downwards, so it can pull in fresh air from the gap between the feet and the bottom. Some cases have an inverted layout, or have a different airflow setup – check your case's manual to see which way your PSU should be installed.

MOUNT MOTHERBOARD AND COOLER

Your next job is to install your motherboard and cooler. Start by fitting the motherboard's rear I/O shield into the hole at the back of the case, which will be in your motherboard box. There will be small metal grips around each of the port holes, which you need to leave in place – they help to grip the ports, but their primary job is earthing.

Snap the I/O shield into position, which will require a firm push in each corner **26**, and then remove any unwanted expansion slot covers that cover the slots you'll be using for your graphics card and other expansion cards.

Grab your CPU cooler's radiator, if you're using an all-in-one liquid cooler, and keep hold of it while you put your motherboard in place. Use all the mounting points possible to secure the motherboard to the case; be careful not to scrape the bottom on any metal edges and make sure every mounting hole sits on top of a standoff – these standoffs look like screws with another screw-thread in the top, and they will be supplied with your case – sometimes pre-installed.

Their purpose is to provide a gap between the motherboard and the metal motherboard tray, ensuring that none of the solder points on the back of the board gets short-circuited. Likewise, make sure that no standoffs sit under a part of the motherboard that doesn't have a mounting hole, or you could end up with a short circuit too. When the motherboard is tightly in position, with the ports pushed through the I/O shield, and a standoff hole clearly visible in every screw-hole, you can screw the motherboard into place using the screws provided with your case's screw kit **27**.



You can now fit the radiator if you're using an all-in-one liquid cooler, which will usually need just four screws (or eight screws for a dual-fan 240mm or 280mm model) **28**. Follow the instructions for your cooler in terms of which screws you use where. As with an air cooler, make sure the fans are positioned so they're pushing air through the radiator and out the back of the case. The rear of the fan usually has a label and supports over the blades, and the rear needs to be facing the back (or top) of the case, with the front (normally blank) facing the front (or bottom) of the case.

CONNECT POWER AND LEDS

Your case will include a bunch of cables for connecting the power and reset buttons, the LEDs and any audio jacks and USB ports. We've shown some of these connectors below so that you can identify and connect them to your motherboard **29** **30**. As with any cables, take the time to route them properly, rather than simply plugging them in and leaving the cables loose. Some motherboards, such as our example Maximus VIII Hero, also have an adaptor



for these connectors, to save you having to fiddle around in your case – use it if you have one, as it saves a lot of hassle.

FRONT PANEL PLUGS



Power, reset, hard drive LED and power LED headers – connect your case's buttons and lights to the motherboard



USB 3 connector – connects your motherboard to your case's USB 3 ports



USB 2 connector – connects your motherboard to your case's USB 2 ports



Audio header – connects your case's audio jacks to your motherboard

INSTALL GRAPHICS CARD

You can now slot your graphics card into the top large PCI-E slot (usually the first or second slot below the CPU). Once it's sitting firmly in its slot, secure the back bracket in place. Some cards require two backplates rather than one, but either way, they all need to be either screwed into place, or secured with the tool-free mechanism if your case has one **31**.



FIT DRIVES

SSDs and hard disks mount in various ways, depending on the case you'll be using. Many need to be secured inside brackets first, while others simply slot into a cage or screw into a mount in the case. Hard drives get hot, so try to position them near your case's front intake fan, if it has one.

Meanwhile, SATA SSDs are best installed on 2.5in mounts behind the motherboard tray, or on top of the PSU cover if your case



has one, like our example. These mounts usually just require you to screw the SSD's bottom into the mount with four screws **32**. If not, you'll have to use a drive bay and, if possible, rotate the drives so that the connectors face away from you as you look at the case side-on, which will make it easier to build a neat system.

The same applies to any hard drives you're fitting – fit them with their connectors facing the right side panel if possible. There are various different mounts for hard drives, but most will either require you to screw the bottom of the drive into the mount **33**, as with our example, or use holes in the side of the SSD. Either way, follow your case's instructions to fit your any hard drives. Many cases let you remove drive bay cages you're not using too, and doing so can improve your



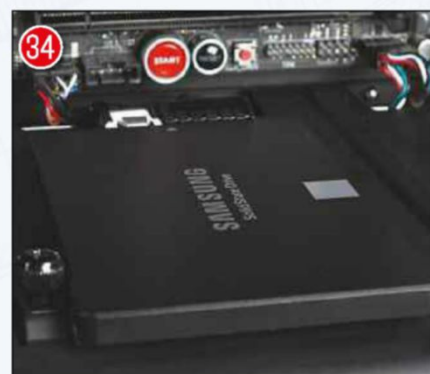
case's cooling, as the airflow from front to back is less obstructed.

Meanwhile, DVD or Blu-ray drives will be mounted in the front of the case using a 5.25in bay, if your case has one. Many people choose not to install an optical drive now, as software is readily available online or on quicker, smaller thumb drives. Plus, they create a lot of vibration, take up space and some new cases don't even come with 5.25in drive bays.

Plenty of cases still have 5.25in bays, though, so if you still want an optical drive, perhaps for Blu-ray playback or CD ripping (after all, lossless audio still isn't widely downloadable in the mainstream), then that's

still possible. You may need to remove a metal blanking plate at the front of the case behind the panel covers first. You can then remove one of the covers and slide your drive into place. Some cases will have tool-free mounts here that clip the drive into place. Otherwise, your case will come with the appropriate screws needed for installation on either side of the drive.

With any SATA drives, you'll also need to route a SATA cable from the drive to the motherboard's SATA ports – in our case, there was a perfect gap between the graphics card and the case for routing SATA cables, but whatever case you're using, you'll



want to route your SATA data cables from the drive, around the back of the system and back through to the motherboard, to keep them out of the way **34**. You might notice at this point that we've moved our SSD mount from the right of the PSU cover to the left, which is because our SATA power cable clashed with the case's USB 3 cable, showing that you can never do too much cable checking before you install your hardware!

Finally, hook up any other parts that need power, such as LED strips, fans, fan controllers and pumps for liquid coolers, making good use of cable-routing holes to keep the interior free from hanging wires.

TIE CABLES

Once you've threaded your PC's cables through the various routing holes and hidden them as best as possible, you need to tie them down to keep them in place. Some cases will come with cable ties or Velcro straps, but it's worth investing in a bag of cable ties of various sizes so you can tie down as much as possible.

Try to group cables together side by side, rather than stacking them on top of each other, and use any holes in the frame to anchor the cables in place. Thread your cable tie through the anchor point around your cable **35**, pull it tight and finally snip off the end with your plastic cutters **36**.



If, like ourselves, you're using a non-modular PSU, you'll also need to tie down all the cables you're not using – our case has perfect anchors for this purpose under the drive bays, but you should be able to find other anchor points for these cables on other cases – if not, you can always improvise using the holes in drive bay mounts. The end result should have the cables tied flatly against the rear. It doesn't need to look pretty, but it does need to be secure and flat enough for you to refit the side panel **37**.

CONFIGURE EFI AND INSTALL WINDOWS

Double-check that all your power plugs are in the right sockets, and that all your components are properly in place, then plug your PC into the mains, plug your monitor into your graphics card, connect your keyboard and mouse, and push the case's power button. If nothing happens then follow the troubleshooting tips from earlier in this guide.

If your PC powers up fine, then insert your Windows 10 installation thumb drive (available from www.scan.co.uk), or put your Windows installation disc into the optical drive. Some motherboards give you the option to select your boot device on their start-up screen – if so, select your DVD drive or USB stick and kick off the Windows installation process.

If not, tap the Del key on your keyboard to enter the EFI system when your PC starts, find the boot section and set the first boot device to either your USB thumb drive or the optical drive – whichever one you're using to install Windows.

In the Windows installation, select the right language; you'll then be given the option to install Windows on a specific drive. You want to install Windows on your fastest drive – an M.2 NVMe drive if you have one, or a 2.5in SATA SSD – you can install Windows on a mechanical hard drive if you want too, although it will be much slower.

Select your fastest drive and Windows will then get to work on installation. The PC will



eventually restart, at which time you need to remove the DVD or USB stick, and set the first boot device to the drive on which you're installing Windows.

Once you're into Windows, install your motherboard's Ethernet or Wi-Fi driver, get your PC online and download the latest Windows updates. After that, visit your motherboard manufacturer's website to get the latest Windows drivers – start by installing the Intel chipset driver, then install the other ones. Now is also a good time to install any software for your motherboard – Asus' motherboard software, for example, enables you to colour-match its LEDs to the



rest of your system, making it look great.

Finally, download the latest AMD or Nvidia driver for your graphics card from either www.amd.com or www.nvidia.com. Once they're installed, change your desktop resolution to the native resolution of your monitor – right click anywhere on your Windows desktop, select Display settings, click on Advanced display settings and then select the correct resolution.

Once you've installed Windows and your drivers, and set up your monitor properly, you should have a well-built, clean-looking PC that's ready for your software and games. Enjoy it! **GPG**





GARETH HALFACREE'S

Hobby tech

The latest tips, tricks and news in the world of computer hobbyism, from Raspberry Pi, Arduino and Android to retro computing

TUTORIAL

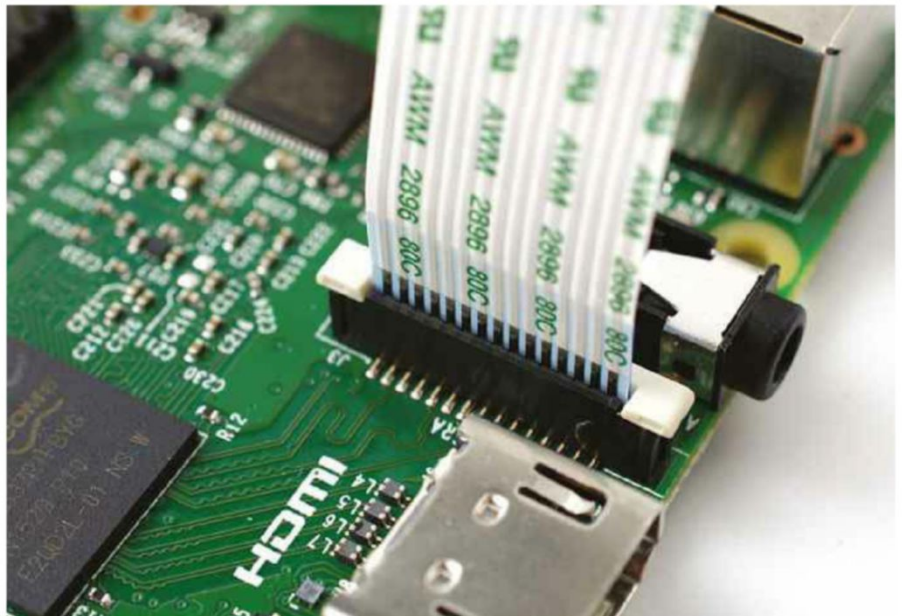
Raspberry Pi time-lapse video

The launch of the £4 Raspberry Pi Zero was a landmark moment for the affordable computing movement, but it certainly cut a few corners to hit that price. The launch of a new revision, which adds back the Camera Serial Interface (CSI) connector, albeit in a high-density format that requires a special cable, gave me a reason to revisit a classic project: Pi-powered time-lapse photography, now compatible with all Raspberry Pi models.

When I originally built a time-lapse rig, for the Raspberry Pi User Guide's first print run, time-lapse support was built into the camera software, but it was buggy; I needed to write a surprisingly lengthy shell script to fix it. That's all changed now though – you'll only need extra software if you're looking to turn the string of captured images into a video directly on the Pi. If you're looking to use a Pi Zero for your time-lapse project, check out the ZeroView case (£7 inc VAT from <https://thepihut.com>), which attaches to a window via suction cups and holds both the Zero and the Camera Module.

1 Install camera module

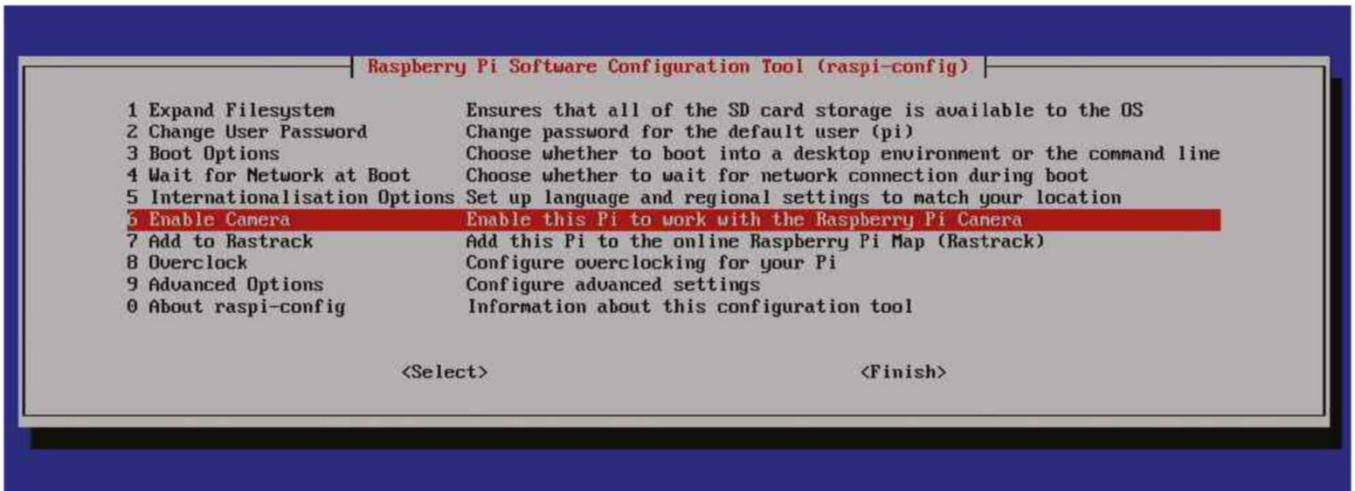
The single five-megapixel camera, which was my only choice when I first started playing



Don't worry if a little silver is still showing on the camera's cable; it's perfectly normal

with the Pi, is now a four-strong family; the original five-megapixel Camera Module now competes with an eight-megapixel Camera Module 2, and both are available in Noir variants lacking the infrared cut-out filter – allowing them to be used with infrared LEDs in complete darkness.

Regardless of which camera you choose – and if you don't need the extra resolution, there's no reason to throw out an original Camera Module in favour of the newer model – they're all installed in the same way. Ensure the Pi isn't connected to power, then lift the flaps on the CSI port, which you'll find near the



Enable the camera in the configuration tool

HDMI connector on full-sized Pis, and to the right of the board on a Pi Zero. Insert the ribbon cable with the shiny side facing away from the flap, hold it straight and push the flap back home. It's normal for some silver contact to still be visible; if the ribbon cable withstands a gentle tug and looks straight, it should work.

2 Activate camera module

While all Raspberry Pis include Camera Module support, it must be manually enabled. Power up your Pi and make sure your Raspbian installation is up to date by typing the following at the terminal:

```
sudo apt-get update && sudo apt-get upgrade
```

Load the Raspberry Pi Configuration Tool with the following command:

```
sudo raspi-config
```

Find the Enable Camera option – numbered six at the time of writing, although that can change when new menu entries are added, and press Enter. Choose Enable, press Enter again, then press Enter a final time to reboot the Pi.

3 Begin capturing

Point the Camera Module at your chosen subject, make sure it's firmly in place and not likely to move, and enter the following commands to begin a time-lapse capture:

```
mkdir frames
cd frames
raspistill -o frame%08d.jpg -t1 10000 -t 600000
```

This process creates a directory called 'frames' and then launches the image capture software in timelapse (-tl) mode with a ten-

second delay between captures – a good starting point for testing. After ten minutes (the '-t 600000'), the capture session will automatically terminate, or you can stop it early with Ctrl-C.

The '%08d' in the file name is a shell expansion, which adds an incrementing eight-digit counter to the output.

4 Install av-tools

When the capture has finished, you'll have a folder full of still images, which you can convert into a video directly on the Pi using the av-tools library. At the terminal, install av-tools with the following command:

```
sudo apt-get update && sudo apt-get install libav-tools
```

The library doesn't take up much room on the Raspberry Pi's SD card, but the final video could be massive, so make sure you have plenty of room on the SD card, or connect an external storage device to the Pi, before continuing.

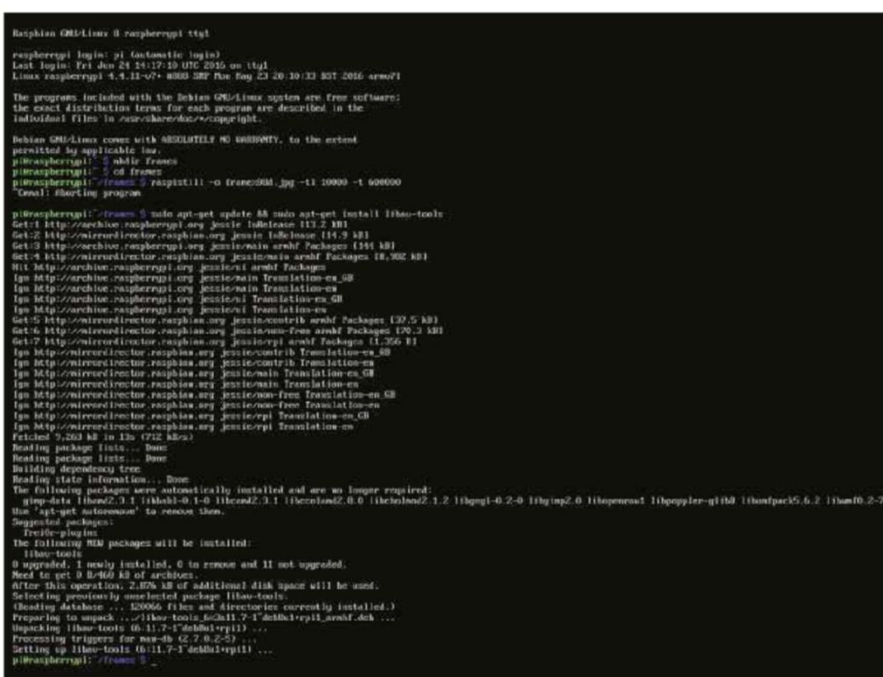
5 Make the video

Converting the still images into a video file with av-tools is simple. From the 'frames' directory, type the following command:

```
avconv -r 10 -i frame%08d.jpg -r 10 -vcodec libx264 timelapse.mp4
```

This command converts the images into a video running at a rate of 10fps – 100 times faster than real time – using the H.264 codec.

The output file is a standard H.264 MP4 video file – albeit one without an audio track – and it can be edited in any video editing application for post-processing. However, this process takes a long time, even on the impressively fast Raspberry Pi 3. If you're in a hurry, it may be faster to copy the images to a desktop or laptop computer and run the conversion there.



The avconv utility can be installed quickly, but the processing task is pretty resource-intensive

REVIEW

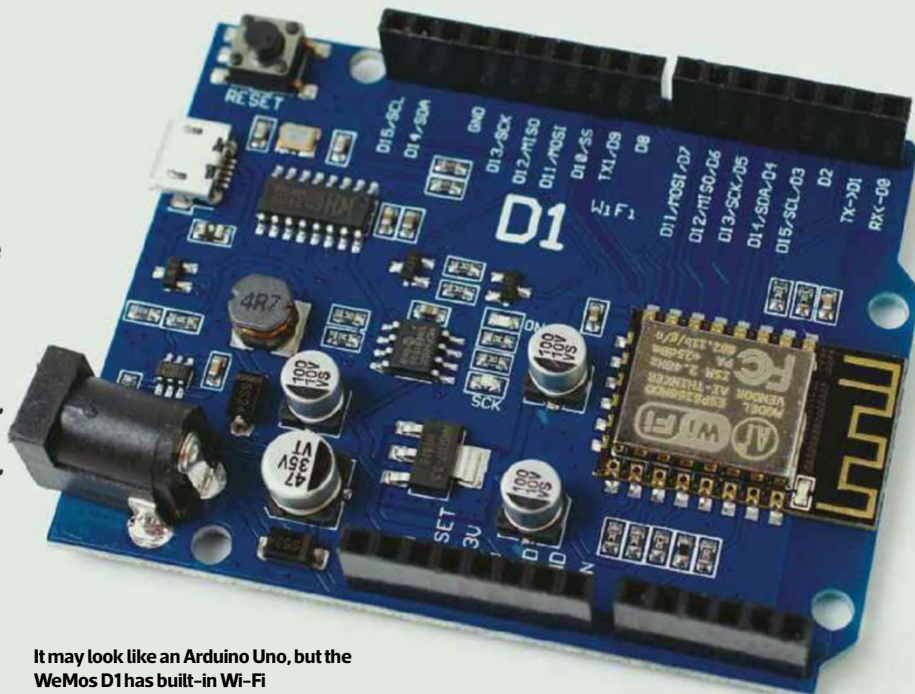
WeMos D1 R2

I've been doing a lot of shopping in China lately, typically via AliExpress – the consumer-facing version of business-to-business giant Alibaba, where there are plenty of bargains available, including a wealth of ESP8266-based microcontroller boards offering Arduino-style features and integrated Wi-Fi for as little as £1.30 (VAT exempt as long as the total order value is below £18).

These boards aren't beginner-friendly though. They require a USB-TTL adaptor to program, and while these adaptors are cheap, using one isn't as quick and easy as just sticking a micro-USB cable into a socket. Also, they're not breadboard-compatible in their standard layout.

Enter the WeMos D1. Initially, you'd be forgiven for thinking it's an Arduino: it has the same blue circuitboard, the same layout – even down to the annoying offset pin headers – and the same power and USB inputs. Rather than having an Atmel ATmega microcontroller at its heart, though, the WeMos D1 acts as a breakout and programming board for an ESP8266 module, which gives it an immediate set of advantages over the Arduino Uno.

The biggest advantage, of course, is an integrated 2.4GHz Wi-Fi connection, allowing it to connect to a nearby wireless network and act as anything from a remote sensor to a



It may look like an Arduino Uno, but the WeMos D1 has built-in Wi-Fi

fully functional web server. You also get a surprisingly powerful CPU, capable of running at 80MHz or 160MHz – ten times the 16MHz clock frequency of an Arduino Uno. Flash memory is increased to 4MB as well, compared to just 32KB on the Uno.

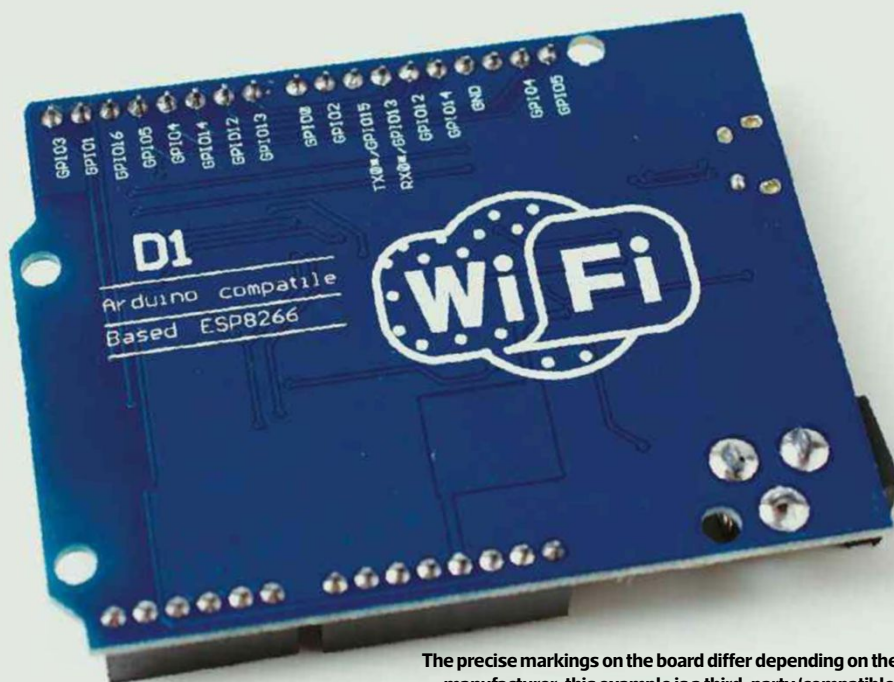
There are, however, disadvantages. While the WeMos D1 shares the physical layout of an Arduino Uno, the ESP8266 doesn't have

enough pins to finish the job: while an Arduino Uno has 14 digital I/O pins and six analogue input pins, the ESP8266 – and, by extension, the WeMos D1 – has nine user-accessible digital I/O pins and just one analogue input pin.

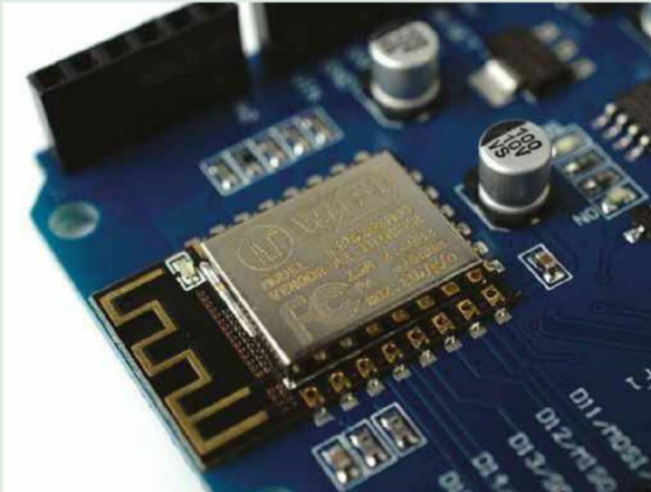
Getting the board up and running can be awkward too. The WeMos D1 uses the same community-provided libraries and toolchain as any other ESP8266-based board, which are easily added to the official Arduino IDE using the Board Manager utility. Once installed, though, choosing from the various options – from serial baud rate through to SPI flash size – can be tricky. If you've picked up an official WeMos D1, the instructions will get you on the right track. If, like myself, you opted for a cheaper third-party compatible, though, you can expect a little trial and error before your first example sketch successfully compiles and uploads to the board.

The WeMos D1 isn't restricted to use with the Arduino IDE, although that's the easiest way to use it: the board can also run the NodeMCU firmware (<http://nodemcu.com>), which provides a Lua interpreter running live on the device for interactive programming over the USB connection. In either case, you'll find plenty of generic ESP8266 support articles that apply perfectly to the WeMos D1.

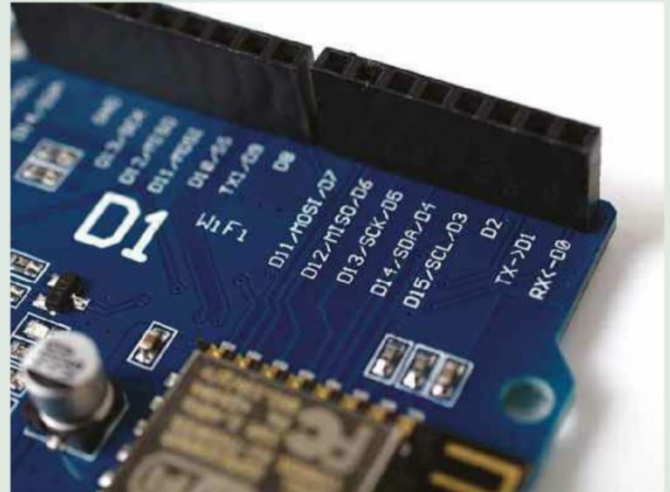
Once the setup process is complete, the WeMos D1 really shines. It's fast enough to



The precise markings on the board differ depending on the manufacturer; this example is a third-party 'compatible'



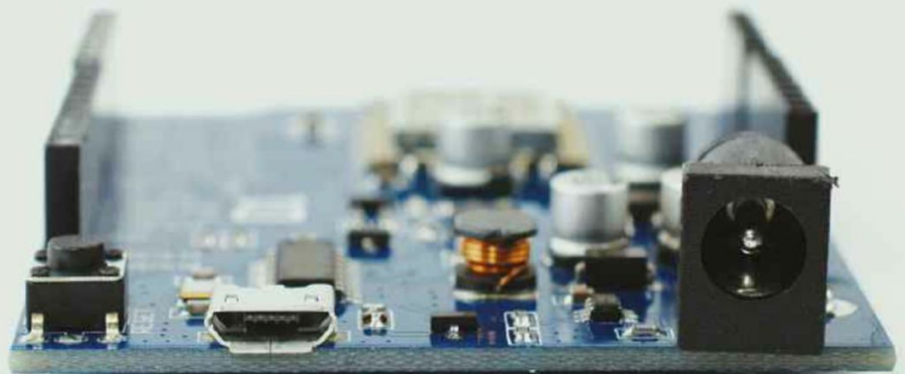
The ESP8266 module is the brains of the board, providing both the microcontroller and Wi-Fi radio feature



The Arduino-like pin headers are present and correct, but the ESP8266 doesn't have enough pins to finish the job

result in errors on benchmark utilities because it completes the tasks too quickly, it's compatible with the bulk of the sketch examples in the Arduino IDE and a selection of ESP8266-specific sketches is supplied to get you started with using its Wi-Fi capabilities. Sadly, this otherwise impressive compatibility doesn't really extend to add-on Shields designed with the Uno in mind though: despite mechanical compatibility, the missing pins coupled with 3.3V rather than 5V logic means the Uno-style layout isn't quite as handy as it first seems.

That's nitpicking though. The WeMos D1 is far easier to program and use than a bare ESP8266, and having built-in Wi-Fi (which is good enough to pick up my living room router from the top-floor bedroom, despite relying on a board antenna) is a real game-changer for many projects. Yes, the WeMos D1 lacks the cloud integration and excellent support of



The board accepts power through its USB programming port or the DC jack, just like a 'proper' Arduino

a device such as the Particle Photon, that's true. A Photon will set you back around £20 (inc VAT) from a UK supplier, though, while the WeMos D1 – or a compatible device, at the very least – can be purchased from a variety of sellers on www.aliexpress.com for as little as £3.30 (VAT exempt below £18) including free worldwide shipping.

Better still, once you've got the hang of working with the ESP8266 module on which

the WeMos D1 is based, you can pick up the cheaper bare modules for integration directly into your creations. With a cost of around £1.30 (VAT exempt below £18) per module, there's no cheaper way to add both a microcontroller and a Wi-Fi connection to your projects.

More information about the WeMos D1 can be found on the official WeMos website at www.wemos.cc

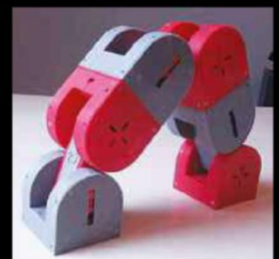


The ESP8266 examples get you up and running with Wi-Fi quickly and easily

NEWS IN BRIEF

Dtto Modular robot hits v1.0

A modular robot project created by a team at Universitat Rovira i Virgili in Spain, called Dtto, has hit version 1.0. Inspired by the MTRAN III robot created by the Japanese National Institute of Advanced Industrial Science and Technology, the 3D-printed robot segments can automatically attach to one another in a variety of layouts thanks to embedded rare-earth magnets. Each segment is controlled by an Arduino Nano microcontroller with Bluetooth and NRF2401+ radio modules, while movement is provided by five TowerPro servo motors. More information, plus the files to print and build a Dtto project yourself, can be found at <https://github.com/otrebla333>



REVIEW

The Essential Guide to Electronics in Shenzhen

I do all my Chinese sourcing via websites such as AliExpress and Taobao, but anyone who needs thousands of units rather than individual odds and sods are better off visiting in person. Shenzhen is China's electronics paradise: you can pick up everything there from smartphones to long-obsolete components hand-salvaged from old military gear. Every year, hobbyists from around the world flock to the area for Maker Faire Shenzhen, and even outside 'tourist season', you'll find plenty of foreigners walking the streets in search of bargains.

However, the vendors don't usually speak English, and if your Mandarin is as rusty as mine, you'll have little to no hope of getting across your requirements or figuring out that the components aren't what you thought until it's too late and a shipping crate is already on the way.

It's a problem that Andrew 'bunnie' Huang has sought to solve with The Essential Guide to Electronics in Shenzhen. Funded via pre-orders on Crowd Supply, it's designed to be a hands-on tool for

English-speaking visitors to Shenzhen. The heart of the book is a series of point-to-translate pages, spiral bound for easy access. They cover all the technical questions you could ever want to ask, from the colours of LEDs to the quantity and quality queries that could spell the difference between a dream deal and a nightmare. Simply turn to the page, find the English box matching your query, and point; the vendor can then read the Mandarin, presented in both transliteration and Hanzhi, and point to the answer.

That alone makes The Essential Guide, well, essential for anyone going to Shenzhen without a translator, but its contents doesn't stop there.

The book also includes maps of the area covered by translucent plastic pockets; vendors are asked, again using point-to-translate, to mark their location on these maps and provide business cards for later follow-up contact, while a slightly larger pocket can be used for handouts or parts samples. This way, all these bits are kept neatly organised for future reference.

Finally, the book includes the kind of advice you can



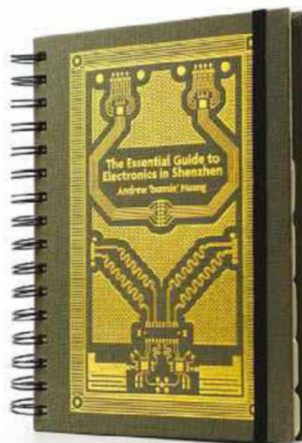
While not as flexible as a hired translator, the point-to-translate pages are extremely useful

only get from bitter experience. In the introductory and closing sections, Huang details all sorts of advice, from how to cross the border into Shenzhen to key issues with component quality and how they could affect usability in final projects. You won't find tourist information – there's nothing about hotels, where to eat, or nightlife – but that's by design rather than omission. This book concentrates on what an electronics enthusiast would need to know, and can be easily supplemented with a tourist guide for more general information.

The Essential Guide is, by design, a niche product. If you're not planning on going to Shenzhen any time soon, it will serve little purpose (although the gold-embossed cover looks mighty attractive on a shelf) and the maps concentrate solely on the Hua Qiang district and its electronics vendors, making them useless for tourism purposes. The prose sections, while interesting, also take up too little of the book to give it longevity.

If you're heading to Shenzhen for the electronics markets, though, this book is indeed essential. For the newcomer, it's likely wise to go with an experienced group and hire a translator; with a visit or two under your belt, this book should be all you need for a successful trip.

The Essential Guide to Electronics in Shenzhen is available from www.crowdsupply.com for \$35 US plus \$14 shipping outside the US (around £38, VAT exempt). **GPD**



It's certainly eye-catching, but this guide isn't designed to simply sit on a shelf looking pretty

NEWS IN BRIEF

Netherlands launches nationwide LoRa network

The Netherlands has become the first country in the world to have a nationwide Long Range (LoRa) radio network for Internet of Things (IoT) applications, following numerous smaller-scale rollouts worldwide. Built by telecoms provider KPN, the LoRa network went live in Rotterdam and The Hague in 2015 before being rolled out to the entire country.

Compared to Wi-Fi and Bluetooth, LoRa uses much less power and has a longer range. Unlike mobile networks, the cost of connecting a device and transmitting small amounts of data is minuscule. Projects currently using KPN's LoRa network include rail switch monitoring at Utrecht Central station and depth sounders in the Rotterdam port.



Gareth Halfacree is the news reporter at www.bit-tech.net, and a keen computer hobbyist who likes to tinker with technology. [@ghalfacree](https://twitter.com/ghalfacree)

CUSTOM PC

REALBENCH 2015

in association with **ASUS**

Give your PC a workout with our new benchmark suite, and see how your rig compares to other readers' machines

BENCHMARK YOUR PC

Download the benchmarks from www.asus.com/campaign/Realbench and, before you run them, disable any power-saving technologies in your BIOS that change your CPU clock speed, or the leaderboard won't record your overclock frequency properly. To post a score on the leaderboard, go to Save Upload File in the RealBench 2015 app's Results menu, and save your results in an RBR file. You need to select Offline Uploads on the leaderboard site, sign up for an Asus account and upload your file.

Gimp

We use Gimp to open and edit large images. Unlike our previous Gimp test, this one uses more than one CPU core, although it's still more sensitive to clock speed increases than more CPU cores.

Handbrake H.264 video encoding

Our heavily multi-threaded Handbrake H.264 video encoding test takes full advantage of many CPU cores, pushing them to 100 per cent load.

SHOUT OUTS!

There's been little change in the top 20 this month, but last month's new entry Nik is still tweaking his machine further, improving his PC's overall score from 188,136 to 193,102.

LuxMark OpenCL

This GPU compute test is the only synthetic part of our suite, although the renderer is based on the real LuxRender physically based rendering software. As 3D rendering is a specific workload that not everyone will use, and because OpenCL support isn't standard in most software, this section is given just a quarter of the weighting of the other tests in the final score.

Heavy multi-tasking

Our new multi-tasking test plays a full-screen 1080p video, while running a Handbrake H.264 video encode.

Scores

RealBench 2015 breaks down the scores for each test, then gives you a total system score and a percentage reference score.

On an Intel system, the 100 per cent reference score comes from a stock-speed

Core i7-4790K, with 16GB of Corsair 2400MHz DDR3 memory, a 240GB OCZ 150 SSD, an Asus Maximus Gene VII motherboard and an Nvidia GeForce GTX 780 3GB graphics card.

On an AMD system, the 100 per cent reference score comes from a stock-speed A10-7850K APU, with 8GB of Corsair 2,133MHz DDR3 memory, a 256GB Plextor M5 Pro SSD and an Asus A88X-Pro motherboard, using the APU's integrated graphics. **CPC**

CHROME WARNING

At the moment, Google's Chrome browser flags up the RealBench 2015 download as potentially harmful, and we're aware of this issue. The file is perfectly safe, however – please ignore this warning.

CUSTOM PC REALBENCH 2015 LEADERBOARD

RANK	SYSTEM SCORE	REFERENCE	USERNAME	MOTHERBOARD	CPU	CPU CLOCK	MEMORY	PRIMARY GPU
1	275,683	240.9%	8pack	Asus Rampage V Extreme	Intel Core i7-5960X	5.5GHz	16GB Kingston 3000MHz	Nvidia GeForce GTX Titan X
2	233,375	203.9%	ian.parry3	Asus Rampage V Extreme	Intel Core i7-5960X	4.6GHz	32GB G.Skill 3200MHz	Nvidia GeForce GTX Titan X
3	231,781	202.5%	CustomPC	Asus Rampage V Extreme	Intel Core i7-5960X	Not reported	32GB Kingston 2666MHz	Nvidia GeForce GTX Titan X
4	221,477	193.5%	Chris_Waddle	Asus X99-Deluxe	Intel Core i7-5960X	4.62GHz	16GB Corsair 3000MHz	Nvidia GeForce GTX Titan X
5	219,415	191.7%	Luke@DinoPC	Asus Rampage V Extreme	Intel Core i7-5960X	4.6GHz	16GB Corsair 3276MHz	Nvidia GeForce GTX Titan X
6	216,006	188.7%	terrystone1	Asus Rampage V Extreme	Intel Core i7-5960X	4.61GHz	16GB Corsair 2992MHz	Nvidia GeForce GTX 980 Ti
7	215,694	188.5%	dubail	Asus X99-Pro/USB 3.1	Intel Core i7-5960X	4.7GHz	32GB Corsair 2800MHz	Nvidia GeForce GTX 980 Ti
8	212,062	185.3%	TEL	Asus Rampage V Extreme	Intel Core i7-5960X	4.62GHz	16GB Corsair 2750MHz	Nvidia GeForce GTX 980 Ti
9	211,331	184.6%	Menthol	Asus Rampage V Extreme	Intel Core i7-5960X	Not reported	32GB G.Skill 3200MHz	Nvidia GeForce GTX 980 Ti
10	208,975	182.6%	Angel	Asus X99 Deluxe	Intel Core i7-5960X	Not reported	128GB G.Skill 2448MHz	Nvidia GeForce GTX 980
11	206,723	180.6%	stuart	Asus Rampage V Extreme	Intel Core i7-5960X	4.41GHz	16GB Corsair 3000MHz	Nvidia GeForce GTX 980 Ti
12	200,464	175.2%	mikey	Asus Rampage V Extreme	Intel Core i7-5960X	Not reported	16GB Corsair 3200MHz	Nvidia GeForce GTX 980
13	198,971	173.9%		Asus Rampage V Extreme	Intel Core i7-5960X	4.4GHz	64GB Corsair 2400MHz	Nvidia GeForce GTX 980 Ti
14	197,964	173%	Carbonleg	Asus X99-E WS	Intel Core i7-5960X	Not reported	32GB Corsair 2400MHz	AMD Radeon R9 200 Series
15	193,102	169%	Nik	Asus Rampage V Extreme	Intel Core i7-5960X	4.2GHz	64GB Corsair 2666MHz	Nvidia GeForce GTX 1080
16	189,230	165.3%	shadowrayne	Asus Rampage V Extreme	Intel Core i7-5960X	4.2GHz	32GB Corsair 2133MHz	Nvidia GeForce GTX 980
17	185,219	161.8%	dax	Asus Rampage V Extreme	Intel Core i7-5960X	3.97GHz	32GB Corsair 2448MHz	Nvidia GeForce GTX 980
18	181,058	158.2%	richcardnpaul	ASRock EP2C602	Intel Xeon E5 2670	3.3GHz	32GB Kingston 1866MHz	AMD Radeon R9 200 Series
19	179,386	156.7%	mboogie	Asus Rampage V Extreme	Intel Core i7-5960X	4.2GHz	32GB Crucial 2133MHz	Nvidia GeForce GTX 980
20	177,350	155%	mauserk98	Asus Rampage V Extreme	Intel Core i7-5930K	4.63GHz	16GB Team Group 3000MHz	AMD Radeon R9 200 Series



ANTONY LEATHER'S

Customised PC

Case mods, tools, techniques, water-cooling gear and everything to do with PC modding

Expanding all-in-one liquid coolers

This month we've revisited a guide to expanding an all-in-one (AIO) liquid cooler using some of the latest coolers to hit the shelves.

Traditionally, these coolers have been sealed units, although in two previous guides, I've looked at how to extend or replace the tubing, as well as adding other components in the loop, looking at both standard kits as well as more flexible coolers such as Raijintek's Triton.

However, the process with the latter wasn't particularly straightforward, as the barbs were tricky to remove and I even had to use a G1/4in tap to remove all the sealant inside. That isn't entirely surprising, of course – the most important issue from a cooler manufacturer's point of view is that leaks are prevented.



It's quite easy to modify many modern all-in-one liquid coolers to add your own water-cooling components

A Corsair GT-series cooler can be modified to add clear tubing and show off coloured coolant

However, the Triton also used aluminium in the radiator, which can cause galvanic corrosion if you dismantle the loop and add copper components, such as additional radiators or waterblocks, although this effect can be minimised by using anti-corrosion coolants or additives.

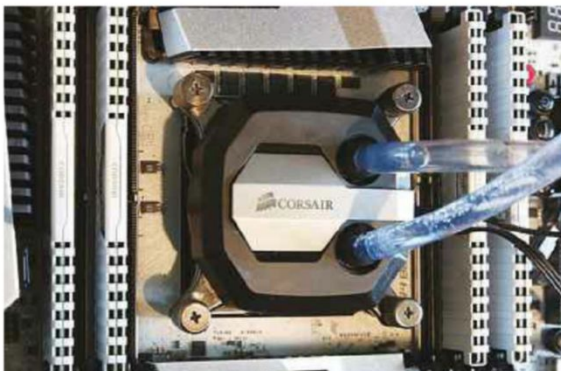
Thankfully, there are one or two AIO coolers that use copper throughout their design, and I've revisited the idea of expanding AIO coolers in our guide this month (see p104). One example I've used is Fractal Design's Kelvin, as both its waterblock and radiator use copper and inert brass, plus its fittings/barbs are far easier to remove than those of the Triton. I've also looked at expanding a Corsair H80i GT in the same guide.

The question, of course, is whether it's worth it. Would you be better off buying a more powerful and possibly

quieter custom water-cooling pump instead, and can you expect to be able to add a bigger radiator and/or a GPU waterblock to the loop using an AIO cooler? To find out, I connected a modified Corsair H80i GT to a standard GPU waterblock and reservoir, as well as a full-height double 120mm-fan radiator, to see if the H80i GT's small pump can really power a reasonable water-cooling system.

One of the initial issues was that the flow rate was so low that the pump had to be constantly fed with coolant until it engaged. With more powerful pumps, you can usually get away with a few air bubbles in the supply at first, but the H80i GT pump wasn't that powerful. However, once it engaged and started pushing coolant around the loop, it managed fine, albeit with a fairly low flow rate. This flow rate shouldn't impact on performance too much though; the cooling ability will ultimately be down to the size of radiator and fan speed you use.

One issue with the H80i GT, though, is that its pump is quite loud and we definitely recommend lowering its speed using Corsair's LINK software. Doing so obviously had a further impact on the flow rate, but even at 7V, it still had enough power to push water



through the loop, although we'd be wary of using the Quiet mode in the software without keeping an eye on the coolant flow, just in case it stops. This setup included a GPU waterblock, reservoir and large radiator in the loop, of course, so your experience may vary with fewer components, but most AIO coolers with a similar design should be powerful enough to handle a decent-sized radiator and GPU waterblock. If you already have such an AIO cooler, but want to add a GPU or a reservoir to your loop, you could definitely save yourself some cash by expanding your AIO cooler, rather than buying a whole new custom loop from scratch.

Water-cooling Broadwell-E

Part of the lure of Intel's flagship desktop X99 platform is building a super-premium system. A lot of premium X99 PCs are water-cooled, although there are plenty of decent air coolers for LGA2011-v3 CPUs available too. However, to deal with the additional heat from overclocking six, eight and now 10-core CPUs, water-cooling is a good idea. You can get rid of the heat from your system faster and more efficiently by transferring it to a radiator and exhausting it straight out of your case.

In addition, you'll likely be able to build a much quieter X99 system if you water-cool it. A full-height, double 120mm-fan radiator and custom water-cooling loop shouldn't need its fans spinning much above 800rpm to deal with the heat load from an overclocked Broadwell-E CPU. You may be able to squeeze a higher overclock out of your CPU if you water-cool it too. Putting these theories to the test, I coupled our in-house Core i7-6850K with an MSI X99A Titanium motherboard and an XSPC RayStorm Pro water-cooling kit, with the aim of seeing if I could push the CPU much further than the 4.4GHz maximum we've generally seen from it in tests.

Achieving this frequency usually needs between 1.34V and 1.38V, depending on the motherboard, so I started at 1.4V and increased the CPU input voltage a little too. Our target was

4.5GHz, but 1.41V, 1.42V and 1.43V vcores all failed to get us to this frequency, with Prime95's smallfft test failing after more than five minutes. Finally, we found a vcore of 1.47V was enough to get through a round of the RealBench test suite at 4.5GHz, so this frequency is clearly the point where the required voltage jumps up exponentially.

However, even at this hefty voltage, the core temperatures from our 6-core CPU were considerably lower than with the Corsair H100 I used for comparison. The H100 resulted in temperatures quickly hitting the 90°C mark as I breached the 1.4V barrier. However, temperatures remained below 90°C even at 1.47V with the water-cooling gear, and were even in the low 70s at 1.4V, despite the fans being much quieter than those on the Corsair cooler too. Sadly, though, even increasing the vcore to 1.5V couldn't get us a stable clock speed of 4.6GHz.

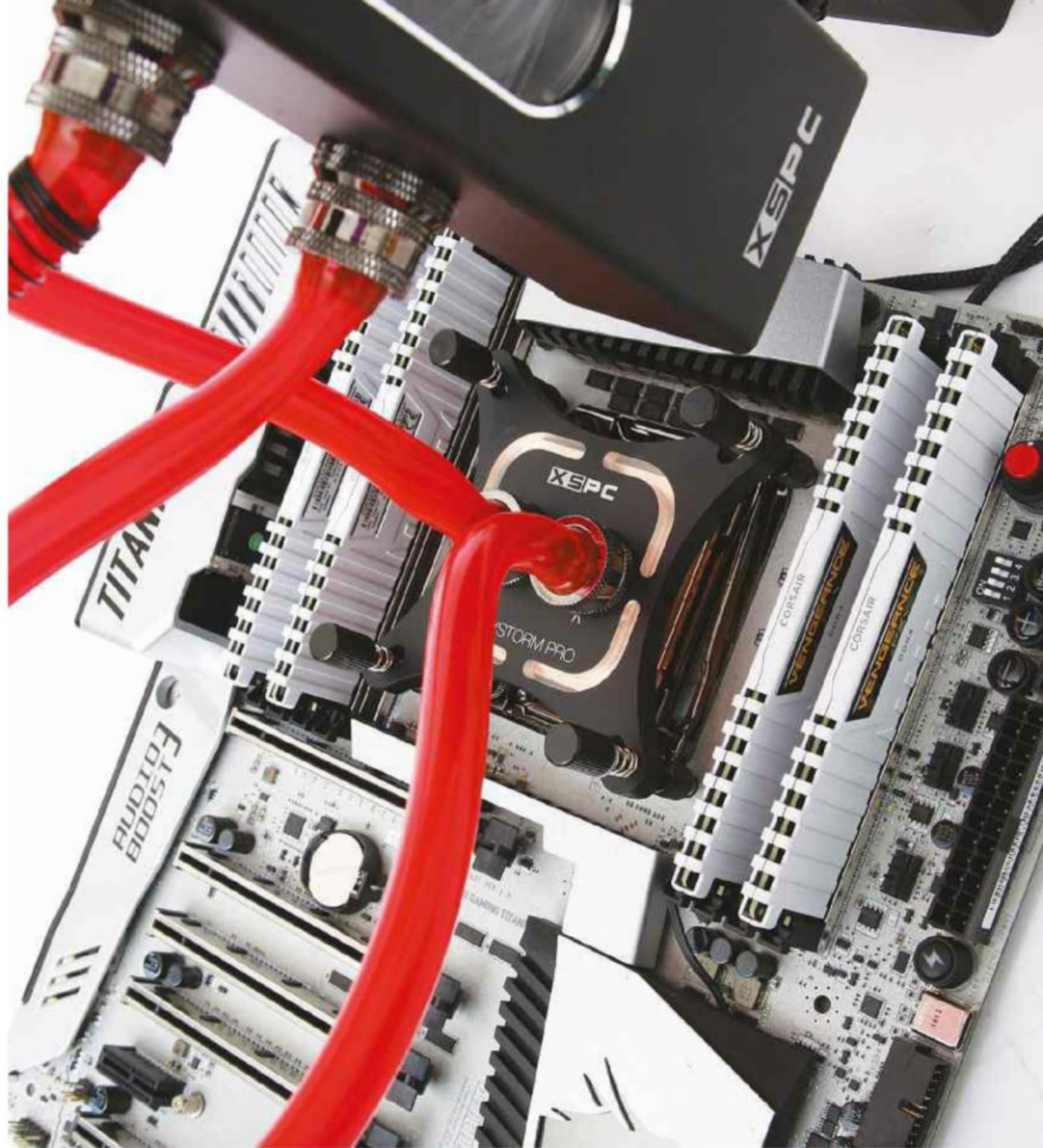
Water cooling enables you to overclock a Broadwell-E CPU without listening to horrible fan noise

In conclusion, you can comfortably get an extra 100MHz out of a 6-core Broadwell-E CPU with water cooling, but not much more.

If you already own a decent AIO liquid cooler then you'll see reduced temperatures, but you won't get much more overclocking headroom.

There's one significant benefit from water-cooling your Broadwell-E CPU, though, which is reducing noise. Even at a fairly modest speed of 1,500rpm, the fans in the XSPC kit kept our massively overclocked CPU tamed, and dropping this speed to 750rpm still didn't see the CPU core temperatures rise above 90°C, despite the fans being practically inaudible.

Basically, while water cooling won't give you a massive clock speed boost from Broadwell-E if you already own a decent all-in-one liquid cooler, it can still yield some impressive results in terms of operating temperatures and very low noise levels. **GPC**



How to Expand an all-in-one liquid cooler

Want to add a bigger radiator or a separate reservoir to your all-in-one liquid cooler? Antony Leather shows you how it's done

 **TOTAL PROJECT TIME** / 48 HOURS

We first looked at expanding all-in-one (AIO) liquid coolers a couple of years ago, but several new models have since entered the market that require slightly different techniques if you want to open them up, fit your own tubing or extend them with other components. You might want to increase the length of tubing from the pump to the radiator, or even to add a GPU waterblock or reservoir. Similarly, it's also possible to upgrade your AIO liquid cooler to use a larger radiator for better cooling, or to give you the space to run larger fans at a slow speed, reducing noise.

In this guide, we've looked at expanding for two popular types of coolers – Corsair's Hydro GT/GTX series with braid-covered tubes, and also Fractal Design's Kelvin series, which handily sports standard G1/4in compression fittings. Both coolers can be expanded to include other hardware in their loops, plus you can replace the tubing with clear PVC tubing, enabling you to show off some coloured coolant. If you're aiming high, you can even add rigid tubing and compatible fittings for it too.

TOOLS YOU'LL NEED



Pliers and Stanley knife /
Most hardware stores

Water-cooling components /
www.watercoolinguk.co.uk



1 / IDENTIFY YOUR COOLER

Look at your cooler to see how you can access its parts. Raijintek and Fractal Design's latest coolers use standard G1/4in fittings, so they're easy to modify, while most of Corsair and NZXT's coolers require you to remove the tubing to get at the barbs underneath.



2 / BARBS OR THREADS?

Coolers with threaded barbs allow you to use your own fittings, as long as the threads are G1/4in size. For barbs, you need third-party tubing and it's best to heatsink it over the barbs to avoid needing jubilee clips. Don't use cable ties as they can become slack.



3 / WHAT DO YOU WANT TO ADD?

Whichever cooler you own, it will be possible to add other components into the loop, such as a reservoir or larger radiator. Make a plan for the parts you want to add, and where you want to put them in your case, so you know how much extra tubing to buy.

CORSAIR HYDRO GT/GTX COOLERS



1 / CLEAN CONTACT PLATE

To prevent getting your hands covered with thermal paste, clean the contact plate of the cooler using a cloth and some TIM clean solution, or isopropyl alcohol. Otherwise, be prepared to get messy.



2 / REMOVE BASE SCREWS

If necessary, remove the base screws and mounting rings from the cooler so that you can access the base of the tubes, and remove the top fascia of the pump section.



3 / CUT THROUGH PLASTIC COLLAR

On Corsair's recent coolers, there's a plastic locking ring sitting over the tubing. You'll need to cut off this ring with a Stanley knife to be able to remove the tubing. You won't need it later, so it can be discarded.



4 / REMOVE COLLAR

To remove the collar, cut down one edge using the knife. Don't worry about cutting the tubing, as we'll be removing it anyway. You should then be able to pry off the collar.



5 / CUT THROUGH RUBBER TUBE

The Corsair H80i GT that we used in this example uses thick rubber tubing, but it's easy to remove this tubing by cutting a long line around an inch from the base. You may need to cut through it several times.



6 / PRY TUBE OFF BARBS

The tubing is quite flexible, so try bending it one way after you've cut from the base an inch or so along it. You should easily be able to pry off the tubing afterwards, revealing a silver barb underneath.



7 / DRAIN COOLANT

Once you've removed the tubing, drain the coolant into a sink. It's usually colourless, odourless and shouldn't stain. Tip the radiator above the rest of the unit to make sure all the coolant is removed.



8 / REMOVE PUMP FASCIA

Corsair's pumps have three sections – the contact plate, two foam pads and the top fascia. Pry these sections apart so your cooler looks like the image above.



9 / CUT OFF TUBING

The tubing is attached in exactly the same way as the radiator, with two plastic collars sitting over it. Cut off these collars, cut into the tubing and pry it off. The barbs underneath are black plastic.



10 / CLEAN WATERBLOCK

Remove the contact plate's screws that hold it to the pump section, so you can open up the pump and check the copper fins inside. Occasionally, these fins can be clogged; if so, flush it with distilled or deionised water and use a small brush to remove debris.



11 / HEAT TUBING

Our new tubing has an 8mm internal diameter, and this cooler's barbs have a 10mm external diameter. You can heatshrink this tubing onto the barbs using boiling water, which eliminates the need for clamps, while providing a secure fit and a clean look.



12 / PRESS OVER BARBS

Keep the tubing in the hot water for a minute and it will become very flexible. The process may be fiddly, but you should be able to push the tubing over the barbs all the way to the base. Once it's cooled, the fit will be tight enough for leaks to not be a problem.



13 / REASSEMBLE WATERBLOCK

Connect the radiator again and reassemble the waterblock as far as replacing the baseplate, which you'll need to leave off for the next step. Now is a good time to check that all the tubing is fitted securely.



14 / FILL LOOP

Corsair's coolers lack a fillport, so you'll need to fill the loop from the pump section. Place the radiator on a flat surface, lift up the pump section, fill the loop with coolant by pouring it into the pump section and then replace the contact plate.



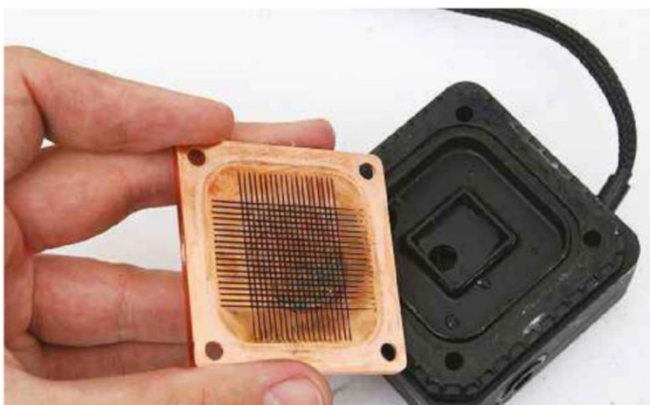
15 / USING A SEPARATE RESERVOIR

Alternatively, you can use a separate reservoir by connecting it in series. Identify the pump section's inlet and make sure the coolant flows from the reservoir to this port – the setup varies between cooler models, so power it up for a couple of seconds to check.



1 / REMOVE PUMP FITTINGS

Moving to Fractal Design's Kelvin coolers, start by removing the pump fittings, which you can unscrew using pliers or molegrips. If you want to use the same fittings afterwards, place some kitchen towel between the grippers and fittings to protect the paintwork.



2 / REMOVE CONTACT PLATE

As with the Corsair coolers, open up the pump section to check the condition of the waterblock. If necessary, flush it with distilled or deionised water and use a small brush to clear out any debris.



3 / DRAIN COOLANT

The Kelvin coolers use similar coolant to Corsair's coolers, which is clear and safe to handle. Drain the coolant out of the pump and radiator into a sink.



4 / REMOVE RADIATOR FITTINGS

As with the pump fittings, the radiator fittings just unscrew from the base, but you may need to use molegrips or pliers to loosen them. Again, place some kitchen towel between the grippers and fittings if you plan to reuse the latter.



5 / FIT YOUR OWN BARBS

We're enlarging the tubing to a more common 13/10mm size and using identically sized compression fittings. Unfortunately, the Kelvin's pump section ports are too narrow for most rigid tubing fittings, but you can use spacer sections if you really want rigid tubing.



6 / CONNECT TUBING

The fittings are just larger versions of the ones included with the cooler. A locking ring sits on the tubing, which is pushed onto a barb. The locking ring then screws down and holds the tubing in place.



7 / ADD A RESERVOIR

Adding a reservoir will not only make your loop look great, but will also make filling the loop, and bleeding air from it, much easier. You'll need to find a suitable location in your case though – some include mounts, but you may need to drill mounting holes.



8 / LOCATE FILLPORT

Unlike the Corsair coolers, the Kelvin coolers at least have a handy fillport on the pump section, so using a reservoir isn't strictly necessary. The fillport is usually on the adjacent side to the ports.



9 / FILL WITH COOLANT

Unscrew the fillport cap and add your preferred coolant. Both the Kelvin's radiator and waterblock are copper, so you don't need loads of anti-corrosion additives. Power on the pump from your motherboard or another PC to leak-test it for 24 hours, then put it in your PC. **GPC**

Folding@Home

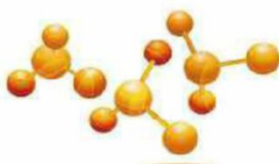
Join our folding team and help medical research

MILESTONES THIS MONTH

USERNAME	POINTS MILESTONE	USERNAME	POINTS MILESTONE	USERNAME	POINTS MILESTONE	USERNAME	POINTS MILESTONE
bobthetoolnut	20000	ShavedCloaca	500000	eteUKLancs	2000000	RaistlinRTCW	10000000
Anonymous		Bleakknav	600000	grozzie	3000000	Acanuck	30000000
oli123456789	20000	Sean_Fletcher	600000	NFGCS	3000000	BCFC_WSM	30000000
richardjohn22	50000	suggestable	600000	Broadwater06	4000000	Bloo_Toon	30000000
ewink20	70000	Fersigo	700000	FurstyFerret	4000000	MattEngr	30000000
Daedalus	90000	john251282	700000	mort6dav3	4000000	Simlec	30000000
L33Tdardjedi1984	100000	Pausanias828	700000	PCEnthusiastUK	5000000	Sparkymatt	30000000
wir3d123	100000	Kentara	800000	dazlanc_101	6000000	Assassin8or	60000000
crisderaud	200000	Pickles96	800000	weebob	6000000	Qazax	80000000
Tonyb959	200000	ggyenyen	900000	Aardwork	7000000	SirBenjaminNunn	80000000
BP_Evil_Element	300000	Anonymous	1000000	wew	7000000	Geoff_Ashden	100000000
Nex79	300000	FREE_WORLD	1000000	Tango_Echo_Alpha	8000000	BeezaBob	200000000
Prince_Knight	400000	Ubereme	1000000	Bobthetoolnut	9000000	Desertbaker	400000000
trma97	400000	bastardo_bill	2000000	PURE	9000000	PC_Rich	700000000
mar_duke	500000	elspuddy	2000000	ZeDestructor	9000000	HHComputers	2000000000
OrigamiMasters	500000						

WHAT IS FOLDING?

Folding@home uses the spare processing cycles from your PC's CPU and graphics cards for medical research. You can download the client from <http://folding.stanford.edu> and our team's ID is 35947. Once you pass a significant milestone, you'll get your name in the mag. You can also discuss folding with us and other readers online at the www.bit-tech.net forums.



TOP 20 OVERALL

RANK	USERNAME	POINTS	WORK UNITS
1	Nelio	2,693,877,304	232,054
2	DocJonz	2,569,503,739	202,942
3	HHComputers	2,092,488,294	59,158
4	piers_newbold	1,063,676,027	62,983
5	Scorpuk	992,803,370	36,756
6	coolamasta	942,729,524	186,345
7	Lordsoth	756,693,312	107,330
8	PC_Rich	714,586,111	89,561
9	StreetSam	571,113,589	90,251
10	Slavcho	552,287,679	39,614
11	johnim	532,458,997	83,230
12	Laguna2012	528,228,927	29,684
13	Dave_Goodchild	465,923,185	119,946
14	The_M2B	437,317,888	66,504
15	Desertbaker	408,387,906	25,111
16	apeman556	378,774,306	32,974
17	KevinWright	353,958,146	34,568
18	Dickie	290,584,239	27,271
19	daxchaos	265,711,468	8,833
20	TheFlipside	259,053,659	26,344

TOP 20 PRODUCERS

RANK	USERNAME	DAILY POINTS AVERAGE	OVERALL SCORE
1	HHComputers	5,972,352	2,092,488,294
2	DocJonz	5,351,988	2,569,503,739
3	PC_Rich	2,267,384	714,586,111
4	piers_newbold	2,015,609	1,063,676,027
5	Lordsoth	1,666,233	756,693,312
6	Scorpuk	1,447,999	992,803,370
7	Unicorn	1,159,263	134,320,426
8	Geoff_Ashden	1,091,858	101,007,916
9	Nelio	1,076,385	2,693,877,304
10	apeman556	1,041,423	378,774,306
11	madmatt1980	971,199	180,013,303
12	Laguna2012	857,414	528,228,927
13	daxchaos	787,242	265,711,468
14	Desertbaker	776,853	408,387,906
15	KevinWright	743,571	353,958,146
16	Slavcho	360,993	552,287,679
17	BeezaBob	359,911	202,208,567
18	Roveel	353,706	249,420,813
19	Sparkymatt	310,161	32,755,757
20	The_M2B	256,350	437,317,888

Readers' Drives

VioletReality

SEE THE FULL
PROJECT LOG:

[http://tinyurl.com/
VioletReality](http://tinyurl.com/VioletReality)

Stephane Beaulieu wanted a dedicated rig for his HTC Vive room, and went to town with this Parvum build, featuring custom rigid water-cooling and a white, purple and silver colour scheme

CPG: What originally inspired you to build Project Violet?

Stephane: I wanted to build a dedicated HTC Vive machine, and I'd seen a purple, silver and white build on the Internet – sorry, I don't remember the name of the creator. The minute I saw the purple coolant he'd used, a lot of ideas appeared in my head. Violet Reality isn't my first

Parvum build though. The first time I saw a Parvum case was when Parvum teamed up with my friend Luc Giguere (Akira749) to make a custom S2.0m called Xenomorph – I just fell in love with the case's concept, clean design and the possibilities it presented.

CPG: Where does the name come from?

Stephane: It's a simple combination of 'virtual reality' with the colour theme, to be honest. My first choice was Purple Reality, but another guy asked me why I didn't call it Violet Reality instead – the name is closer to 'virtual reality', and the

flower pattern I'd made with the VIVE logo on the backplate and heatsink fitted well with this name too, so I changed it.

CPG: What hardware did you choose, and why?

Stephane: The main purpose of this build is to be used with the HTC Vive, and it will be put in a special VR room, so it needed VR-capable hardware. I used an Asus Maximus VIII Gene motherboard, which I've used in a lot of builds; I've never had any issues with it – it's one of the most stable and best-performing motherboards I've used and in my opinion, it's one of the best Z170 boards on the market.

I paired this board with an Intel Core i7-6700K. I don't need the raw power of an X99 setup for VR. At the beginning, I sourced a GeForce GTX 980 Ti card for this build, but then the GTX 1080 came out, so I sold the 980 Ti to order a GTX 1080 card. I chose the Corsair Dominator Platinum memory simply because the looks fitted so well with the theme – they just required a little modding, and voila!

CPG: What other mods have you built?

Stephane: I've built over 30 now, and most of them are for personal use; I just like having new stuff on my desk! One of them was built for the EK Vulture Mod Off contest, which I called Gold Wing, and is now in Slovenia at the EK head office. Another one that I like a lot is Devil Eye, which Asus asked me to do for CES 2016. I've also built some mods for charity, such as Go HABS GO!, which is based around a Parvum Veer – I built it for a disabled child, and the theme is based around his idol, the hockey player Carey Price. I've also built mods for various clients around the world.

CPG: What difficulties did you come across?

Stephane: It generally went very well, because I spent a lot of time planning the project, and I knew the potential issues that can occur. One issue was the tubing in the bottom – my first choice of radiator was just 1mm too thick, and I was unable to use 90-degree fittings without the fan blades touching them, so I just swapped this 30mm-thick radiator for a 27mm-thick one.



/MEET THY MAKER

Name Stephane Beaulieu (aka snef)

Age 48

Location Ste-Sophie, Quebec, Canada

Occupation Self-employed – I work with vinyl lettering and printing, as well as PC building

Main uses for PC Gaming and work

Likes Drawing, movies, computer games and a lot of music

Dislikes People who think they're more important than the rest of the world



GPC: Why did you use rigid tubing and did it pose any issues?

Stephane: A couple of years ago I switched to rigid tubing for only one reason, which is the clouding I've seen in clear flexible tubing. I saw a YouTube video of a Singularity Computer using Bitspower Crystal Link tubing, and it was simply a revelation. Flexible tubing is still on my radar though – some builds with flexible tubing are just great, and I still have some

plans to work with it. I also have a plan for using copper tubing – a Hex Gear R40 build by Frida Zoya Bergendal inspired me a lot here – I want to try using this type of tubing in the future, as well as experimenting with glass tubing – I just love the thickness of the glass.

GPC: What tools and machinery did you use?

Stephane: My main tool is simply my working area. I have a really

great shop, which I built last summer. It has dedicated areas for a paint shop and photo studio, as well as a main building area with a lot of space. I also have a 54in eco solvent printer to print and cut vinyl – I make commercial signs, car wrap and more. There's also a press drill, a Dremel (which I can't live without) and a lot of electrical tools. I have a large CNC machine on the way too – it isn't a powerful one, but it's able to cut wood, acrylic and light metal. I





need it for making commercial signs, but it will help me with PC modding too.

GPG: How long did the build process take?

Stephane: To be honest, I don't count the hours that I work on a project, although the cables take a lot of time! The same goes for planning. If I counted every little detail and change I made in the build process, it would be a long time. I try to plan everything, but I always end up changing little things – for example, I think I'd finished around 80 per cent of the work on Violet Reality when I decided to swap all the black screws for stainless steel screws. There's also all the time I spent on graphics

work in Photoshop creating the backplate and heatsink designs, which takes a lot of time for a Photoshop noob like me!

GPG: What did you learn from this project?

Stephane: Always double-check any custom cables you make – I thought I'd tested all the cables individually, and they all seemed to be working perfectly, but I forgot the SATA power cable.

When I first used it, the PSU entered Protect mode (thanks, Seasonic). I had to check all the power cables (24-pin, PCI-E and CPU power) and they all worked perfectly, then I saw that I'd the mismatched 5V and 12V wires on the SATA cable. Everything worked perfectly afterwards.

Basically, you need to be patient, don't rush anything and double-

check everything, from the power cables to the tightness of the water-cooling fittings.

GPG: Are you happy with the end result, and is there anything you'd do differently if you built it again?

Stephane: Yes, I'm really happy with it, but nothing is ever perfect – I always want to change something later. If I got hold of another Parvum R1.0, I might put the pump in the bottom section and the reservoir on top. I'd hide all the tubing around reservoir, so you just see the reservoir, giving it a much cleaner look, with just the two tubes for the CPU and GPU.

I might also add a second GeForce GTX 1080 card in SLI configuration – not just for performance, but also aesthetic reasons – I just love to see SLI or CrossFire graphics cards featured in a build. **GPG**

BE A WINNER

To enter your machine for possible inclusion in Readers' Drives, your mod needs to be fully working and, ideally, finished based in the UK. Simply log on to www.bit-tech.net and head over to the forums. Once you're there, post a write-up of your mod, along with some pics, in the Project Logs forum. Make sure you read the relevant rules and advice sticky threads before you post. The best entrant each month will be featured here, where we'll print your photos of your project and also interview you about the build process. Fame isn't the only prize; you'll also get your hands on a fabulous selection of prizes – see the opposite page for details.

SYSTEM SPECS

CPU Intel Core i7-6700K

Graphics card MSI GeForce GTX 1080 Founders Edition

Case Parvum Systems R1.0

Memory 16GB (4 x 4GB) Corsair Dominator Platinum DDR4 2666MHz

Motherboard Asus Maximus VIII Gene

Storage 240GB AData SP550 M.2 SSD, 1TB Samsung SSD 850 Evo

PSU Seasonic Silent Snow 750W

Cooling Custom water-cooling loop, featuring EKWB CPU and GPU waterblocks, Bitspower tubing, fittings and reservoir, EKWB Vardar white fan, Darkside LP radiator, Feser One purple coolant, Darkside purple, white and silver 4mm sleeving, Darkside modular white LED strip

Win all these prizes!

We've teamed up with some of the world's leading PC manufacturers and retailers to offer this great range of prizes to each lucky Readers' Drives winner. If your creation is featured in the magazine then you'll walk away with all of the prizes listed on this page, so get in your entries!

Corsair graphite Series 230T case and RM 550w Modular power supply

TOTAL VALUE £150 inc VAT / **MANUFACTURER** www.corsair.com

Corsair believes that a great PC starts with a great case. The Corsair Graphite Series 230T is a compact expression of this core philosophy. With stylish looks and a choice of three different colours, it packs in a remarkable number of features to provide builders with tonnes of room for expansion and amazing cooling potential. Like all Corsair cases, it's built using the finest materials and finished to the highest standards, so it will withstand several years of upgrades. Plus, to make sure it stand out from the crowd, the 230T features Corsair's new Air Series LED high-airflow fans, providing distinctive lighting with low-noise, high-airflow cooling.

Just as a quality case is essential to building a quality PC, a high-performance, a high-quality power supply is also a vital ingredient. The all new RM series has been built from the ground-up to deliver unmatched reliability alongside 80Plus Gold efficiency, and all with the absolute minimum of noise. It uses specially optimised quality parts to reduce sound at the component level, and it's completely silent below 40 per cent load, thanks to its Zero RPM fan mode. It's also fully modular, allowing for the maximum amount of flexibility during installation. With a Corsair Graphite 230T case and an RM 550W Modular power supply at the heart of your build, you'll have the foundations for a truly awesome gaming machine.



Mayhems coolant and dyes



VALUE £50 inc VAT / **MANUFACTURER** www.mayhems.co.uk

Cooling performance is only one part of the equation when it comes to kitting out your rig with custom water-cooling gear. The other major bonus is that all those tubes and gleaming fittings just make your PC look damn sexy, and they look even better when they're pumped full of fancy coloured coolant. As such, we're particularly pleased to have the folks at Mayhems now on board with Readers' Drives; they're currently offering two 1-litre bottles of Mayhems' Pastel Ice White coolant, along with a selection of five dyes, so you can choose the colour that best complements your PC. Check out the blue coolant in our own mini PC mod on the cover of Issue 109 for an example of what's possible with some Mayhems coloured coolant.

Phobya Modding Kit

VALUE £50 inc VAT **MANUFACTURER** www.phobya.com, www.aqua-tuning.co.uk

The Phobya modding kit is designed with the modder in mind, offering great value for money and quality products. The kit includes Nano-G 12 Silent Waterproof 1,500rpm multi-option fans, which use an innovative fan-blade design. As standard, the fans include braided black cables to keep your case looking as neat as possible. The fans are also supplied with a special cable that lets you run the fan at 5V rather than 12V, reducing the noise emitted in order to help you to build a silent system.

The kit also includes the 60cm Phobya 3-pin Molex to 4x 3-pin Molex Y-cable. This pre-

braided extension cable gives you extra routing options in your case, and it also enables you to run up to four fans from one compatible

motherboard header. Meanwhile, the Phobya SATA 3 cables included in the kit offer the same great quality braiding as the rest of the Phobya range, while also securing your connection with latched connectors.

As well as this, the kit includes the Phobya SlimGuide Controller, which gives you the option to vary the speed of other fans in your case, while the Phobya TwinLEDs let you shine a light on your mods.





JAMES GORBOLD / HARDWARE ACCELERATED

A NEW PC ISN'T ALWAYS THE ANSWER

James Gorbold's summer woes show that, sometimes, you only need to replace a couple of cheap components to get a broken PC working again

While complaining about the British weather is something of a cliché, it does have relevance to Custom PC, as this hot summer forced me to perform my first major system upgrade in well over a year. Before this point, I'd been enjoying the longest period of hardware stability I've ever endured without the upgrade itch getting the better of me.

The problem emerged a few weeks back, when the health-monitoring software on my Asus motherboard started to flash up temperature alerts when I was gaming, with the temperature of some of my components starting to exceed 70°C. I then performed my usual quarterly PC spring clean, taking off the side panel, and giving the dust filters and heatsinks a good clean, which is usually enough to lower the temperatures to normal limits.

However, on this occasion the spring clean wasn't sufficient, and I was forced to speed up the case fans; as somebody who hates machine noise, this was really frustrating. Ultimately, even this extra fan speed wasn't enough though; a couple of weeks later, my wife noticed a build-up of black dust around my desk – dust that had become so hot when passing through the PC that it had been burned. It was during this stage that the system also started to lock up when playing games. Enough was enough; I decided that a system refresh was in order.

I nearly did it too. I was about to hit the Scan warehouse with a wish list featuring a new CPU, motherboard, memory and case, when I came to the realisation that I really didn't want to refresh my system. Apart from the recent temperature, noise and black dust problem, it was still performing brilliantly,

despite being based on the X79 platform from way back in 2011. Indeed, while Intel has made some significant performance improvements since 2011 in content creation applications, when it comes to everyday office applications and games, a high-end CPU such as my aging Core i7-3960X is no worse than a brand spanking new Broadwell-E CPU.

My main problem with building a new PC, however, was the misery involved in reinstalling and configuring Windows, applications, games and mods – a process that can take months to get it all back to the way you like it. After a lot of deliberation, I decided that resurrecting my old system was more cost and time-effective than building a new PC.

The answer in the end was simple. I bought a new high-end Noctua air cooler to replace the all-in-one liquid cooler on the CPU, along with some new case fans. The former not only dropped the CPU temperature by a few degrees, but its oversized 140mm fan also helped to reduce the motherboard temperature around the CPU socket too. Swapping out the case fans for modern models with better-designed bearings and blades, as well as new motors, made a massive difference too, not only dropping the motherboard temperature but also reducing the noise compared with the old fans.

Within the space of an hour, my old PC was up and running again, only this time it was cooler and quieter. Ever since then, it's behaved itself impeccably, putting off that dreaded total rebuild and Windows reinstall for a little while longer. I didn't get away scot-free though – the upgrade itch kicked in and so I treated myself to a new graphics card. Happy days. **GPC**

The dust had become so hot when passing through the PC that it had been burned black

James Gorbold has been building, tweaking and overclocking PCs ever since the 1980s. He now helps Scan Computers to develop new systems.



VENOM

BLACKBOOK

15



NOW SLIMMER, LIGHTER & MORE POWERFUL

SCAN[®]

scan.co.uk

Award-winning **3XS FLUID SERIES SYSTEMS**



Watercooled, whisper quiet and overclocked.

Scan Platinum Partners



GAMING PERFECTED.
GEFORCE GTX 1080

NVIDIA's new flagship GeForce GTX 1080 is the most advanced gaming GPU ever created. Powered by the new NVIDIA Pascal™ architecture, the GeForce GTX 1080 delivers up to three times the performance of previous-generation graphics cards



CORSAIR VENGEANCE LED SERIES
HIGH PERFORMANCE

Corsair Vengeance LED Series DDR4 memory modules are designed to provide a unique look with vibrant LEDs and a precision engineered light bar, created specifically to pair with the design themes of most motherboards and PC gaming components.



Intel® Core™ i7 6800K
6th Generation Intel® Core™ Processor

Enjoy unparalleled performance in content creation applications with the NEW Intel® Core™ i7 processor Extreme Edition with up to 10 processor cores, 25MB of Intel® Smart Cache, 40 PCIe® 3.0 lanes, DDR4 2400MHz memory support and the NEW Intel® Turbo Boost Max Technology 3.0.



Contact Scan on 01204 474747 to order your custom built PC.